Vermont state highway department

Needed highway improvements in Vermont. (1941 - 1950 inclusive)

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SPECIAL REPORT

on

Needed Highway Improvements In Vermont

(1941-1950 Inclusive)

Prepared by

The Highway Planning Survey

Vermont State Highway Department

in cooperation with the

Public Roads Administration

Federal Works Agency

FOREWORD

The aim of economic highway planning is to provide within the funds available roads and bridges that are adequate for existing traffic, and that with reasonable maintenance expenditures will remain adequate for probable traffic increases during their normal lives.

The steady growth of motor vehicle travel during the past twenty years has created needs for highways that constantly exceed available revenue. It is logical, therefore, if construction funds are to be used to the best advantage, that they be spent successively on those sections of highway which at the present time show the greatest deficiencies, or which may be expected to become greatly deficient in the near future.

A preliminary report of the Vermont State-wide Highway Planning Survey was published in 1938. In it were described the objectives and methods of the Survey, and certain of its findings were summarized. Since then the data have been analyzed further and all road information and some traffic data have been kept up-to-date. It is now possible to project a ten-year program of highway improvement that presumably will best meet our needs.

This report analyzes the existing deficiencies on the public highway systems in Vermont, and taking into consideration probable future revenues as well as estimated traffic increases it proposes a ten-year construction program based upon the relative urgency with which these deficiencies should be remedied.

The degree of improvement or the standards to which a road should be built are determined largely by the volume and type of traffic, whether the road be a State Highway, a State-aid Highway, a Town Highway or a city street. These standards have been established from the experience of the Vermont State Highway Department, together with the opinions and recommendations of nation-wide technical groups.

While the proposed program is based upon our priority needs according to known facts and carefully studied probabilities, it has been kept flexible enough to permit revisions as they become necessary. The immense National Defense program already has introduced certain requirements which may change somewhat the plans here presented. In this connection, consideration should be given to the development of alternate routes which will relieve traffic congestion on present main highways at a cost considerably less than to rebuild a single highway to take care of all the traffic. We must also recognize the growing need for by-passing large communities. Furthermore, although Vermont is a small State we should keep in mind the possible future desirability of extending in a modified form the National System of straight-line, limited-approach, major highways now being constructed as interstate connections by other States.

The Vermont State-wide Highway Planning Survey is being conducted under the supervision of the State Highway Board and the Commissioner of Highways, in cooperation with the Public Roads Administration of the Federal Works Agency.

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PART 1

THE HIGHWAY SYSTEMS

Legal highways were first recognized in Vermont in 1779. According to old maps there were, in 1796, about 1,100 miles of public highways. By 1825 a somewhat primitive highway transportation system had developed, consisting mostly of turnpikes. In 1832 the General Assembly authorized the laying out of county highways where they were needed.

During the turnpike era (1796 to 1850) over 500 miles of toll roads were built, but with the coming of the railroads the building of highways lapsed and not until 1892 did the public show more than a local interest in roads. During that year the principle of State-aid was established and an advisory highway commission of three members was created. Six years later the unsatisfactory progress in road construction led to the establishment of the office of Commissioner of Highways, but the lack of necessary authority hampered the Commissioner in his duties and it was 1906 before the Vermont State Highway Department actually functioned as a Department. At that time the Commissioner's power was enlarged and he was authorized to supervise the expenditure of all State road funds besides issuing plans and specifications to the town road commissioners. Two other important laws authorized the appointment of county supervisors, and created the State-aid or Selected System of highways upon which all State funds were to be expended.

In 1917 the State of Vermont approved the Federal-aid Road Act. In 1921 the provisions of Federal law required that road projects in any State, in order to be eligible for Federal-aid, had to be on a "system of highways not to exceed 7 percentum of the total mileage" for the State. Accordingly, there was designated in Vermont in 1922 a system of 1,043 miles of the most important State-aid Highways to be known as the Vermont Federal-aid System. This mileage continued to be administered by the towns, but the State participated in the cost of construction and maintenance and exercised general supervision where State funds were concerned as it did on the remaining non-Federal-aid mileage of the State-aid System.

The provisions of the Hayden-Cartwright Act of 1934 removed previous restrictions on the use of Federal funds in municipalities having a population of 2,500 or more, and this Act increased the Federal-aid System by approximately 53 miles. There were 1,095.4 miles on this system on January 1, 1940. (See Table 1.) Since that time a new Federal-aid Route, known as the Jay Mountain Route, has been added to eliminate travelling in Canada when going across the northern part of the State on State Route 105 between Richford and Newport, thus avoiding the inconvenience of Customs inspection and regulations. This addition results in a net increase of 11.6 miles, so that the total Federal-aid mileage as of August 14, 1940, is 1,107.0.

TABLE 1.

MILEAGE OF ROADS AND STREETS ON THE FEDERAL AID SYSTEM
AS OF JANUARY 1, 1940

Surface Type	Federal-aid		
	Rural	Urban	Total
	Miles	Miles	Miles
Block other than brick	-	1.4	1.4
Bituminous surface on concrete	1.3	4.0	5.3
Concrete	281.6	68.9	350.5
Macadam plant mix	-	4.9	4.9
Macadam penetration	81.0	4.7	85.7
Macadam mixed-in-place	74.0	5.7	79.7
Gravel mixed-in-place	270.7	17.4	288.1
Surface treated gravel	185.5	12.6	198.1
Gravel	78.7	3.0	81.7
All types	972.8	122.6	1095.4

In 1931, 1,012.8 miles of State-aid Highways on the Federal-aid System were designated as the State Highway System, excluding that portion of the Federal-aid System in built-up areas. Later, about 750 miles of important State-aid Highways, not on the Federal-aid System, were added to the State System.

The growth of the State System since its creation is summarized as follows:

1931	1,012.8 miles
1932	7.9 miles
1933	12.2 miles
1934	0.2 miles
1935	723.9 miles
1937	3.1 miles
1939	3.3 miles
Total	1,763.4 miles

Adjustments, abandonments and transfers, have modified this total as of January 1, 1940, to 1,755.7 miles of State Highways.

The State Highway System may be subdivided into two groups: (1) Federal-aid and (2) non-Federal-aid. The Federal-aid routes are the trunk line highways and primarily serve inter-city and interstate traffic. The non-Federal-aid State Highways supplement the Federal-aid System by connecting the smaller communities and distribution centers and by serving inter-county traffic which is important but not of major significance. The State Highways are administered entirely by the State.

The State-aid Highways which remained after the establishment of the State Highway System form the secondary or feeder system of roads. These serve mainly the local traffic between communities and towns, but also carry some intercounty and interstate travel.

State Highways do not pass through municipalities or thickly settled areas, but are connected through these areas by State-aid Highways. Those sections of State-aid Highways which form the extension of State Highways through municipalities are termed State-aid Connecting Links.

Town Highways are primarily land service roads and serve for the most part individual farms or small groups of people, besides acting as feeders to the State-aid and State Highway Systems. They are administered exclusively by the towns and municipalities.

The foregoing classifications of Federal-aid, State, State-aid and Town Highways are what may be termed legal classifications. Their object is to indicate the administrative authority and the various appropriations under which they are financed. The State, State-aid and Town Highways comprise entirely separate systems defined by State Laws, whereas the Federal-aid System includes both State and State-aid Highways designated in accordance with Federal laws as eligible to receive Federal-aid appropriations.

For purposes of traffic studies all public highways, regardless of their State or Federal legal classification, have been further divided into Rural and Urban. Those within the boundaries of cities and all incorporated villages are called Urban, while those outside these limits are called Rural. A table showing how the legal highway systems are divided into Rural and Urban highways follows:

Summary of Mileage of Highways as of January 1, 1940

System	*Miles*	*Percent*
Rural State Highways	1,703.0	11.93
Rural State-aid Connecting Links	5.9	0.04
Other Rural State-aid Highways	2,505.6	17.56
Rural Town Highways	9,193.8	64.43
Other Highways[1]	94.4	0.66
Total Rural Highways (Table 2)	13,502.7	94.62

[1] National Forest roads, Federal Development roads, State Forest roads, Private Toll roads, and Military Reservation roads.

TABLE 2.

MILEAGE OF RURAL ROADS ON EACH OF THE SEVERAL HIGHWAY SYSTEMS CLASSIFIED BY SURFACE TYPES
AS OF JANUARY 1, 1940

Surface Type	Highway Systems										Total All Systems
	State Highways /1	State-aid Connecting Links	Other State-aid /2	Town /3	National Forest Highways /4	National Forest Development Roads	State Forest	State Forest Toll	Private Toll	Military Reservation	
	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles
Bituminous surface on concrete	1.3	-	-	-	-	-	-	-	-	-	1.3
Concrete	282.3	2.8	2.0	0.1	-	-	-	-	0.2	-	287.4
Macadam plant mix	-	-	-	-	-	-	-	-	-	-	-
Macadam penetration	83.4	-	7.0	0.7	-	-	-	1.9	-	-	93.0
Macadam mixed-in-place	109.6	0.6	19.7	1.0	-	-	-	-	-	-	130.9
Gravel mixed-in-place	382.9	1.6	41.4	1.0	-	-	-	-	0.9	-	427.8
Surface treated gravel	265.9	0.8	147.0	36.0	-	-	-	4.0	0.8	1.9	456.4
Gravel	577.6	0.1	2156.5	3085.4	13.3	0.8	54.3	7.3	0.5	1.7	5897.5
Graded and drained	-	-	124.5	4022.5	-	-	1.4	-	-	-	4148.4
Unimproved earth	-	-	5.8	1209.6	-	-	0.8	-	-	4.6	1220.8
Primitive	-	-	1.7	837.5	-	-	-	-	-	-	839.2
All types	1703.0	5.9	2505.6	9193.8	13.3	0.8	56.5	13.2	2.4	8.2	13,502.7

1/ Includes 79.9 miles in National Forests,(0.4 miles concrete, 17.8 miles macadam penetration and 61.7 miles gravel.)
2/ Includes 17.5 miles of gravel roads in National Forests.
3/ Includes 8.4 miles of gravel roads in National Forests.
4/ Does not include 79.9 miles of State Highways, 17.5 miles of State-aid roads or 8.4 miles of Town roads in National Forests.

Urban State Highways	52.7	0.37		
Urban State-aid Connecting Links	95.2	0.67		
Other Urban State-aid Highways	123.9	0.87		
Urban Town Highways and Streets	495.2	3.47		
Total Urban Highways and Streets (Table 3)			767.0	5.38
Total All Highways and Streets			14,269.7	100.00

The rural highways constitute 94.62 percent of all highways and streets in Vermont. A more detailed classification of rural highways is shown in Tables 1 and 2.

In addition to rural highways there are 767.0 miles of urban highways and streets, which is 5.4 percent of all highways and streets in Vermont. These are further classified according to surface type in Table 3.

This represents the present extent of our highways. In ten years the initial construction will be largely completed on the State System. This does not mean that Vermont's road problem is solved. If the public investment is to be protected it is necessary to replace roads even as the cars that travel them are replaced. **There is no such thing as a permanent road.**

If not replaced, many pavements now in use will require increasing amounts for annual maintenance even with no increase in traffic. Increased volumes of traffic, higher speeds of passenger cars, and to a lesser extent increased weights and dimensions of trucks, have caused a large mileage of roads built in former years to become inadequate for present-day traffic. The most important highways in the State were the first to have a hard surface, and consequently were constructed to the earlier standards which were far below the standards of today. These are the roads which are now, or soon will be seriously inadequate for the traffic that is using them.

The ability to foresee conditions and to plan properly for these conditions is becoming an increasingly important factor in the building of highways. An examination of past records shows the wisdom of planning for the future, though it must be recognized that such plans should be modified if such a course is made necessary by unforeseen events, or if found to be desirable in the continuing analysis and study of highway use in subsequent years.

TABLE 3.

MILEAGE OF CITY AND VILLAGE STREETS ON EACH OF THE SEVERAL HIGHWAY SYSTEMS
CLASSIFIED BY SURFACE TYPES
AS OF JANUARY 1, 1940

Surface Type	Highway System				Total All Systems
	State Highways	State-aid Connecting Links	Other State-aid	Town	
	Miles	Miles	Miles	Miles	Miles
Brick	-	-	0.1	-	0.1
Block other than brick	-	1.4	0.5	0.1	2.0
Bituminous surface on concrete	-	3.9	-	7.6	11.5
Concrete	16.1	54.8	17.2	16.5	104.6
Macadam plant mix	-	4.9	4.8	-	9.7
Macadam penetration	3.4	2.7	2.7	18.1	26.9
Macadam mixed-in-place	1.6	5.9	7.3	2.2	17.0
Rock asphalt	-	-	1.6	0.3	1.9
Gravel mixed-in-place	15.6	12.1	6.9	14.7	49.3
Surface treated gravel	9.7	9.2	47.2	170.3	236.4
Gravel	6.3	0.3	35.4	216.8	258.8
Graded and drained	-	-	-	45.6	45.6
Unimproved earth	-	-	0.2	1.8	2.0
Primitive	-	-	-	1.2	1.2
All types	52.7	95.2	123.9	495.2	767.0

FUTURE TRAFFIC TRENDS

The standards to which any section of road should be constructed are determined largely by the volume and type of traffic using the road at present, and by the changes which can reasonably be expected in the future.

It is estimated that in 1945 traffic on all highways in Vermont will be 31 percent greater than in 1937, and that in 1950 it will be 45 percent greater than in 1937.

It is impossible to make a complete estimate of traffic trends from traffic counts alone, since complete and continuous records over a long period of time do not exist. However, certain indicative trends are evident at certain points in Vermont and in other States. Other records relating to vehicle use, such as motor fuel consumption, motor vehicle registrations, and the number of licensed motor vehicle operators are on record and can be used as a basis for such estimates. To estimate the future traffic trends in Vermont these records were used in a method similar to that employed in the Public Roads Administration's report submitted to Congress in 1939, entitled: "Toll Roads and Free Roads."[1]

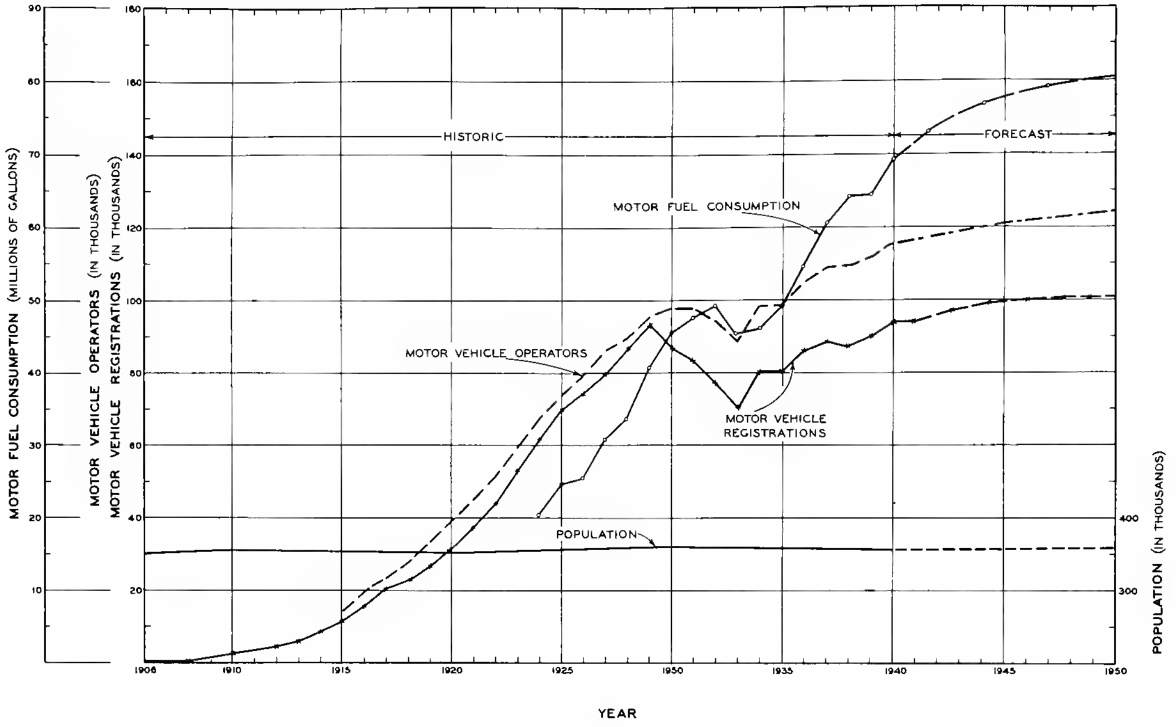
When the interrelationships between population, registered motor vehicles, annual motor fuel consumption per vehicle, and rate of fuel consumption in miles per gallon are studied, it is possible to estimate the total travel in any year which is the mileage travelled by all vehicles.

The data for population, motor vehicle registrations, licensed motor vehicle operators, motor fuel consumption, and their interrelationships are shown in Tables A, B, and C in the Appendix, historic to 1940 and forecast to 1950.

[1] House Document No. 272, 76th Congress, 1st Session.

FIGURE I

RELATION BETWEEN POPULATION, LICENSED MOTOR VEHICLE OPERATORS, MOTOR VEHICLE REGISTRATIONS, AND MOTOR FUEL CONSUMPTION IN VERMONT

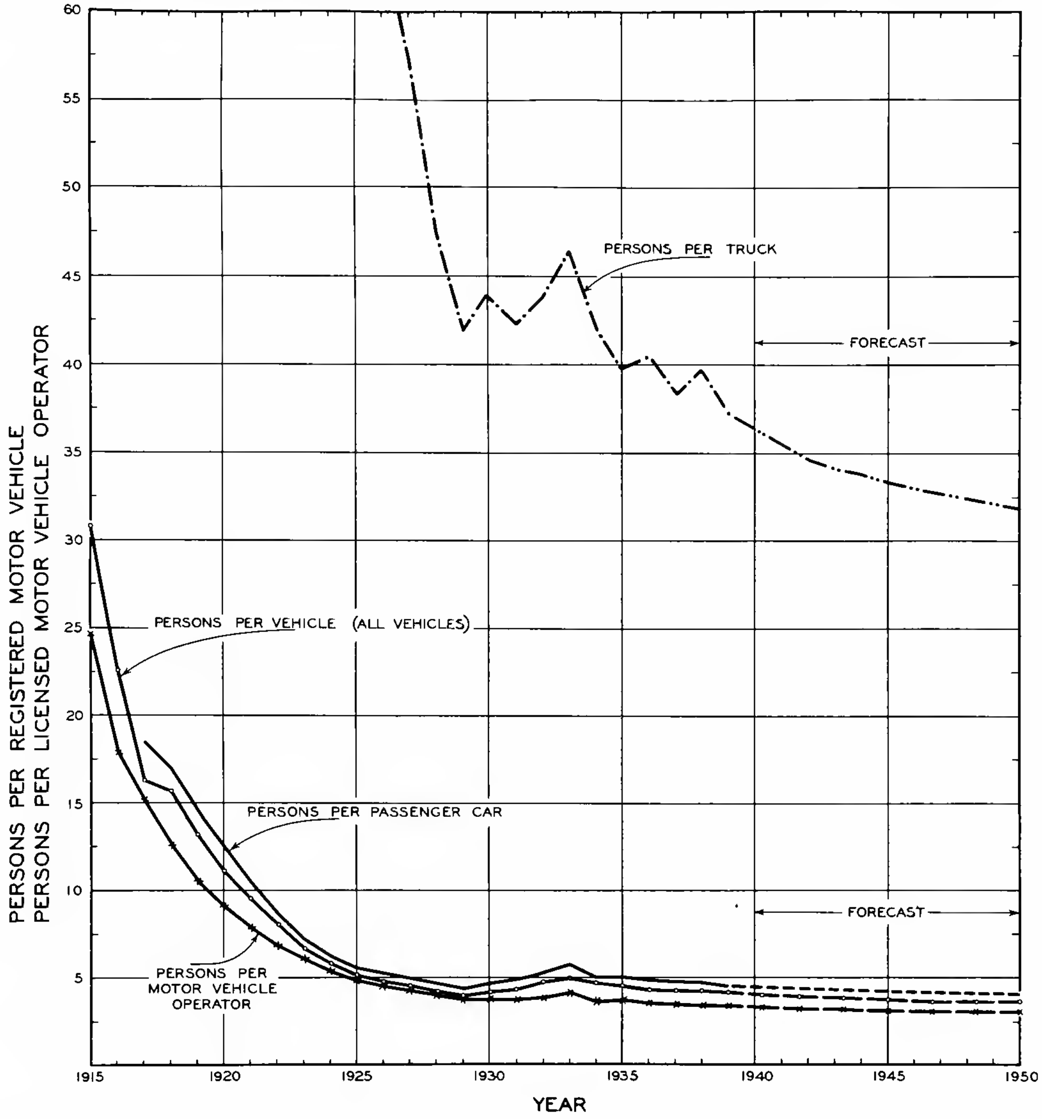


There has been very little change in population in Vermont in recent years. Although there was a slight increase in population in 1930 over 1920, the 1940 census shows a decrease of 380 persons from the 1930 figures. Very little change is anticipated during the next ten years. (See Figure 1.)

Motor vehicle registrations increased steadily up to the year 1929. During the following four years they decreased below the level of 1926 but showed an increase in 1934 that continued to 1937. Registrations decreased slightly in 1938 but increased again in 1939. This trend is shown in Figure 1 together with the estimated registrations for the next ten years. When the number of registered vehicles is compared with the population for each year, a definite trend may be observed indicating that the number of persons per motor vehicle is reaching a saturation point, or will if present trends continue. (See Figure 2, page 15.) This is also true for passenger cars and trucks when considered separately, although it is apparent that the ratio for commercial vehicles is still decreasing faster than that for passenger cars. This means the use of commercial vehicles is increasing at a faster rate than the use of passenger cars. This trend is evidenced in the ratio of commercial vehicle registration to total vehicle registration each year to 1937. (See Table C, page 71, in the Appendix.)

In 1920 there were 11 persons per motor vehicle in Vermont. This decreased to 3.9 in 1929, the smallest in the history of the records of the Motor Vehicle Department. At no time since that year has this ratio been reached, although it was approached in 1939 and preliminary estimates indicate it will be reached in 1940. The increase in persons per motor vehicle from 1929 to 1933 can be explained by the decrease in registration during the depression period. The ratio, however, has decreased in recent years and it is reasonable to assume that it will continue to decrease from 4.0 in 1939 to about 3.6 persons per motor vehicle in 1950. This means that motor vehicle registrations in 1950 can be expected to exceed those of 1937 by about 14 percent, assuming, of course, that road user taxes will not be increased sufficiently to discourage increased use of motor vehicles. For the country as a whole the Public Roads Administration anticipates a slightly smaller number of persons per motor vehicle, which indicates that the Vermont estimate is conservative.

FIGURE 2
INTERRELATIONSHIPS OF POPULATION IN VERMONT
WITH MOTOR VEHICLE REGISTRATIONS AND MOTOR VEHICLE OPERATORS



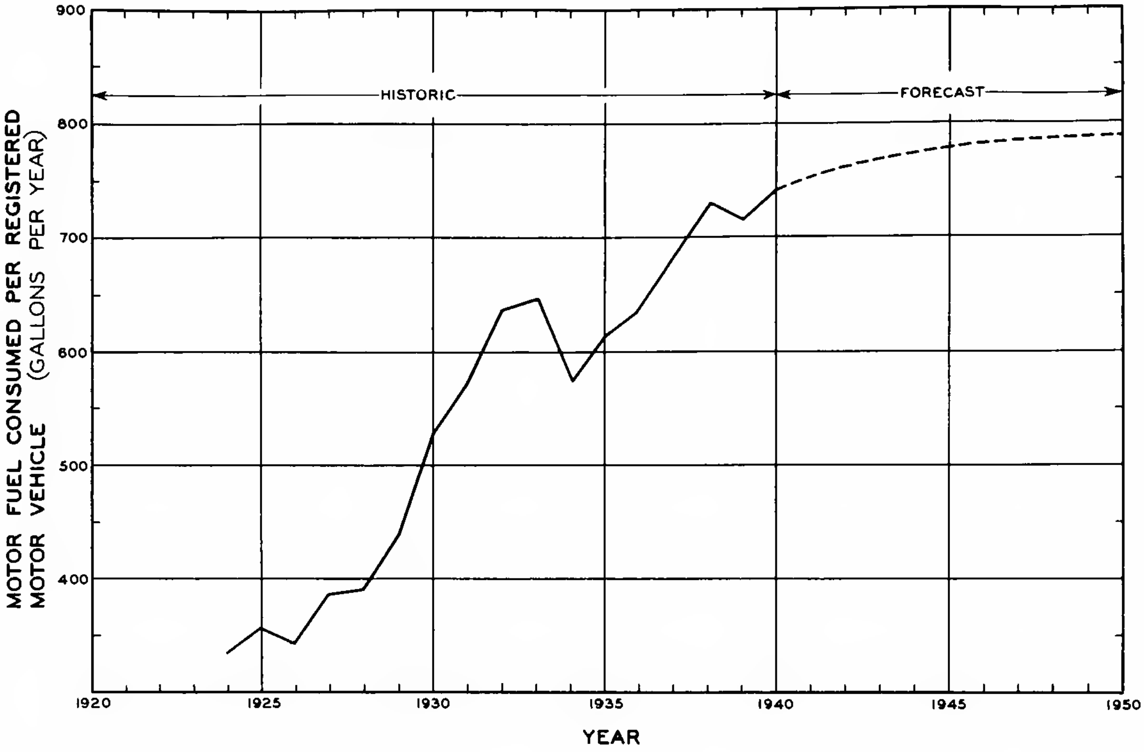
With the exception of the years 1933 and 1938 there has been a steady increase per vehicle in the amount of fuel consumed annually. It is anticipated that this ratio will continue to increase, although at a reduced rate. (See Figure 3, page 16.) This may be offset somewhat by increased operating efficiency of motor vehicles. However, a slight increase in the ratio can be reasonably expected, based on an expected increase in per capita income caused by improved economic conditions, and also on the expectation of an increase in the percentage of commercial vehicles whose rate of fuel consumption is higher than that for passenger cars.

A slight increase may be also expected in miles per gallon of fuel consumed due to improvement in the design of motors and in the fuels used for combustion in the motors. (See Figure 4, page 17). In "Toll Roads and Free Roads," the Public Roads Administration has estimated this increase on a percentage basis.

In this same Figure 4, the percentage relation of each of these factors (vehicles per 100 persons is 100 times

FIGURE 3

MOTOR FUEL CONSUMED PER REGISTERED MOTOR VEHICLE IN VERMONT



the reciprocal of persons per vehicle) is shown with relation to 1937, the year in which the State-wide Traffic Survey was made. From the four different factors discussed above, the estimate for travel is computed and shown for each year as a percentage of 1937.

It is estimated that traffic on all roads in 1950 will be 45 percent greater than in 1937, as is indicated in Figure 4. This represents an average annual increase of 3.5 percent.

It is believed that travel on the trunk line roads will increase at a rate slightly greater than the average for all roads. Property adjacent to a trunk highway develops faster than that on local roads, and the traffic originating along the road, therefore, increases faster. The average length and number of long trips, which are made principally on the trunk highways, are expected to increase at a faster rate than the average length and number of shorter trips. This is because ownership of motor vehicles by urban residents is increasing faster than that by rural residents. The urban residents make longer rural trips, on the average, than the rural residents. The allowance to be made for these factors depends upon the location of specific sections of highways. An additional factor to be considered is traffic which is created by new improvements. Many trips made on improved roads would not be made if the roads were unimproved.

There are certain indications from traffic records at the present time that show the estimate given above and the assumptions which have been made are reasonable.

Automatic traffic recorders have been operated for more than a year at 270 locations on State Highways in 43 States. Although traffic decreased at a few of these locations, the average traffic at all of them increased each month in 1939 and 1940 over the corresponding month of 1938 and 1939. These increases averaged 5.9 percent per year. On State Highways in Maine, this increase in traffic for each month over the corresponding month of the previous year has averaged 3.4 percent at seven locations. In New Hampshire, at three locations this increase over the corresponding month in the previous year has averaged 5.7 percent. In Vermont at two locations this increase over the corresponding months in 1937 has averaged 4.5 and 5.5 percent.

At four other locations in Vermont where counts are being taken this year, an average annual increase of 4.7 percent is shown over the 1937 traffic count. On many road sections on the Vermont State Highway System, preliminary results from a series of traffic counts begun this year to bring the 1937 traffic data up to date, indicate increases in traffic volume in excess of the annual estimate for all roads.

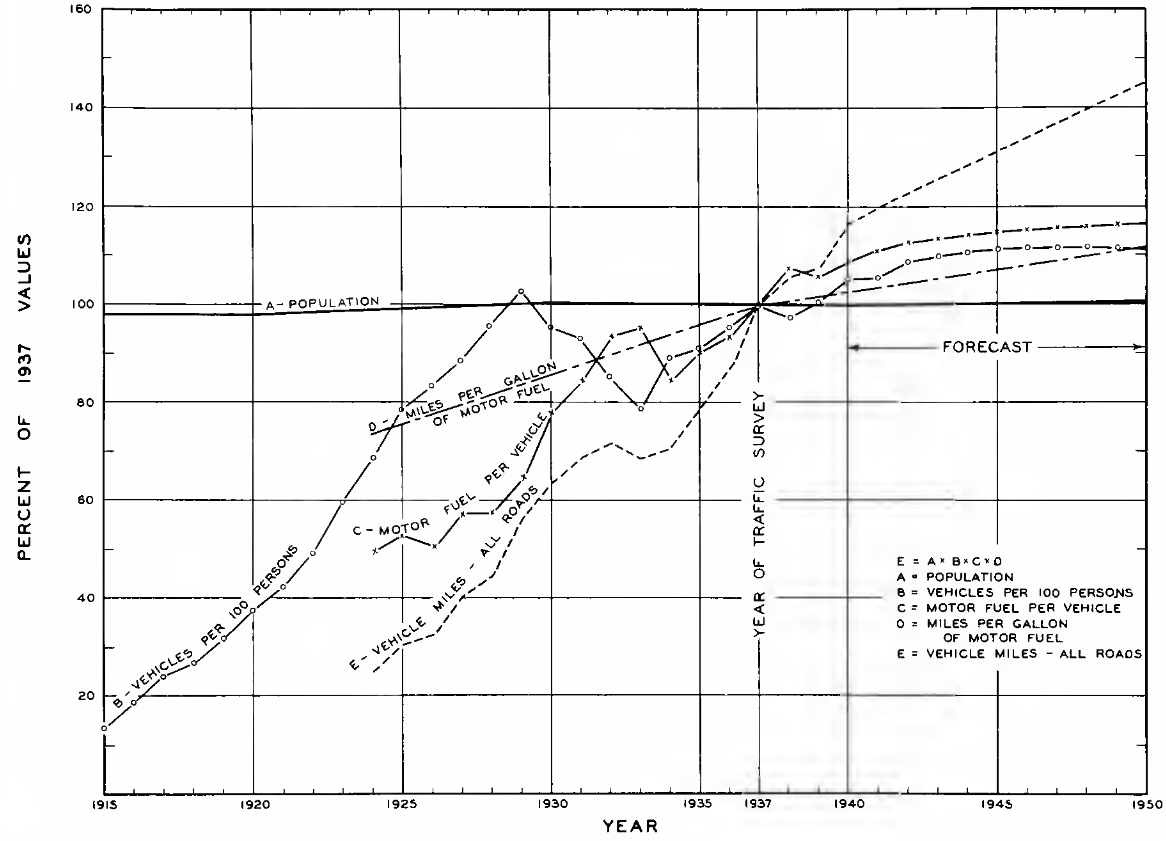


FIGURE 4
TREND IN VEHICLE - MILES OF TRAVEL ON ALL ROADS IN VERMONT

DESIGNING FOR THE FUTURE

In planning and designing highways, it must be recognized that the investment is made for a considerable period of time. Experience has proved that different road surfaces have service lives of different durations. If it is known that a given road surface can be expected to last for a certain period of time, such as, for example, twenty years, it is logical and economical to plan that road to standards which will be adequate for traffic needs throughout most of that time. **We should not build highways for today's traffic only, but for the traffic which will use them next year and in the years to come.** For the first few years it may sometimes appear that a highway has been overbuilt. However, increased traffic created by the improvement, and normal traffic growth thereafter, soon makes the facility fully utilized.

This has been our experience in past years. It was impossible to anticipate the tremendous growth in traffic which has taken place in the past 15 years. It would be a poor investment, indeed, if plans were made for the replacement of existing roads or surfaces in kind or in the same location unless adequate not only for present traffic but also for the anticipated traffic of the near future.

Vermont does not have the population nor the industry which create the large traffic volumes existing in some States. Moreover, the proportion of traffic consisting of large and heavy trucks and truck combinations is smaller here than in many other States. Vermont trends in these vehicle types seem to lag somewhat behind those of the more populous States. However, it may be reasonably expected that the trucks and combinations now operating in considerable numbers in other States will eventually be found in increasing numbers on Vermont highways. **Knowing the trends in Vermont traffic growth, and profiting by the experience of other States, it should be possible to design our highways for the traffic volumes and type of vehicles which must be served in the relatively near future.**

HIGHWAY STANDARDS

In order that motor vehicle operators on Vermont roads may be adequately served with highways as durable and safe as it is possible to construct with the funds available, certain elements in design of roads must be considered.

These elements are:

- Sight Distance
- Curves
- Grades
- Surface Width—Two Lanes
- Multiple Lanes—more than Two Lanes
- Type of Surface
- Congestion in Urban Areas
- Highway Structures
- Grade Crossings

When these elements involve certain materials, dimensions, or conditions, the highways are considered to be as safe and convenient for travel as they can be expected to be built. When they fail to equal these dimensions, materials, or conditions in whole or in part, the highway is deficient in one or more respects for safe and adequate service to the motoring public.

The speed at which people want to travel is an important factor in determining the adequacy of roads. Roads which are entirely safe for 30-mile-per-hour traffic may be distinctly inadequate for high-speed trunk line highways. While the elements mentioned above should be studied for all roads, the standards which should be applied will necessarily be much higher on State Highways than on State-aid Highways where traffic is satisfied and adequately served with roads of lower standards. On Town Highways the service demanded is even less, and standards can be correspondingly lower. These three types of highways may be classed roughly as high speed, moderate speed, and low speed highways, respectively.

Sight Distance

Restricted sight distance impedes the free movement of vehicles and is inadequate when the passing of vehicles is obstructed to such a degree as to seriously delay or irritate the average driver. Such restricted sight distances are caused by both horizontal and vertical curves, and by obstructions along the highway right-of-way such as embankments, buildings, and trees.

The design committee of the American Association of State Highway Officials has determined that a vehicle traveling 50 miles per hour can safely pass a vehicle traveling 25 miles per hour in the same direction, if there is a 1,000-foot sight distance ahead.[1] It is necessary to have a clear sight distance of 350 feet to stop safely a vehicle traveling 50 miles per hour. Therefore, it is highly desirable to have 1,000-foot minimum sight distance in non-mountainous areas and 650-foot minimum sight distance in mountainous areas where it is not possible to travel at high sustained speeds. **In Vermont where much of the State is hilly and grading is correspondingly costly, present construction on State Highways is based on 500-foot minimum sight distance, although 1,000-foot sight distances are obtained where practicable.**

Restricted sight distances can sometimes be improved, if not entirely eliminated, by such action as clearing the right-of-way and cutting the brush on adjacent property. Frequently, however, they can be remedied only by costly relocation.

At present, on our rural State Highway System there are 5,277 places where the sight distance is less than 500 feet. This is equivalent to 3.1 places of restricted sight on every mile of State Highway in the State. (See Table 4, page 20.)

There are: on 476.6 miles of High Type Surface, 930 sight restrictions, or 2.0 per mile; on 648.8 miles of Intermediate Type Surface, 1,598 sight restrictions, or 2.5 per mile; and, on 577.6 miles of Low Type Surface, 2,749 sight restrictions, or 4.8 per mile.

Restricted sights on highways surfaced with high and intermediate type surfaces are considered more dangerous because these two types of road carry the largest volumes of traffic at the highest speeds.

Even on the most heavily travelled roads of the State there are many places where sight distance is too short.

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[1] A policy on sight distance for highways. American Association of State Highway Officials, 1940.

RESTRICTED SIGHT DISTANCE

Restricted sight distance impedes the free movement of vehicles.

TABLE 4.

RESTRICTED SIGHTS ON THE RURAL STATE SYSTEM

Surface Type	Average 24-hour Traffic (1937) Vehicles	Miles	Sight Distances less than 500 feet Number	Number per mile
High	0 - 299	21.7	19	0.9
	300 - 599	50.9	120	2.4
	600 - 999	115.9	224	1.9
	1000 - 1999	213.0	447	2.1
	2000 - 2999	68.0	110	1.6
	3000 & over	7.1	10	1.4
	All Groups	476.6	930	2.0
Intermediate	0 - 299	72.6	158	2.2
	300 - 599	237.6	515	2.2
	600 - 999	219.2	544	2.5
	1000 - 1999	119.4	381	3.2
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	648.8	1598	2.5
Low	0 - 299	398.9	2100	5.3
	300 - 599	174.5	633	3.6
	600 - 999	4.2	16	3.8
	1000 - 1999	-	-	-
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	577.6	2749	4.8
All Types	All Groups	1703.0	5277	3.1

High Type: Bituminous surface on concrete, concrete, and all types macadam.

Intermediate Type: Gravel mixed-in-place and surface treated gravel.

Low Type: Gravel.

On the 68 miles of high type surface carrying from 2,000 to 3,000 vehicles per day, for example, there are 110 places or 1.6 per mile, where the sight distance is less than 500 feet.

Curves

In addition to causing restricted sights at some locations, curves cause traffic to slow down in order to travel safely. An object travelling a circular path tends to leave the path because of centrifugal force. On highways this can be partially overcome by banking and widening the curves, but the amount to which the outside of a curve can be elevated is limited because of the tendency of slow-moving vehicles to side-slip into the opposing lane of traffic, particularly on ice-coated pavements. The maximum practical superelevation is about 1¼ inches per foot of pavement width. Limited technical investigations indicate that the average automobile driver feels a lurching sensation when travelling at a speed of 60 miles per hour on curves sharper than 6 degrees superelevated in the amount of 1¼ inches per foot of width. For this reason a 6-degree curve is considered the sharpest at which it is safe to drive at 60 miles per hour. At 50 and 40 miles per hour the sharpest curves which can be safely travelled are, respectively, 9 degrees and 14 degrees.

Recognizing the impracticability of providing for extremely high speeds in Vermont, present State Highway construction standards are based on a maximum curvature of 7 degrees.

On all rural State Highways, 1,703.0 miles, there now are 4,410 curves in excess of 7 degrees. This is equivalent to 2.6 on every mile of State Highway. (See Table 5, page 20.) A large percentage of these curves are over 14 degrees and many are as high as 30 and 40 degrees.

There are: on 476.6 miles of High Type Surface, 811 curves in excess of 7 degrees, or 1.7 per mile; on 648.8 miles of Intermediate Type Surface, 1,334 excessive curves, or 2.1 per mile; and, on 577.6 miles of Low Type Surface, 2,265 excessive curves, or 3.9 per mile.

TABLE 5.

EXCESSIVE CURVES ON THE RURAL STATE SYSTEM

Surface Type	Average 24-hour Traffic (1937) Vehicles	Miles	Curves In excess of 7 degrees Number	Number per mile
High	0 - 299	21.7	11	0.5
	300 - 599	30.9	114	2.2
	600 - 999	115.9	181	1.6
	1000 - 1999	213.0	398	1.9
	2000 - 2999	68.0	97	1.4
	3000 & over	7.1	10	1.4
	All Groups	476.6	811	1.7
Intermediate	0 - 299	72.6	109	1.5
	300 - 599	237.6	423	1.8
	600 - 999	219.2	483	2.2
	1000 - 1999	119.4	319	2.7
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	648.8	1334	2.1
Low	0 - 299	398.9	1721	4.3
	300 - 599	174.5	531	3.0
	600 - 999	4.2	13	3.1
	1000 - 1999	-	-	-
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	577.6	2265	3.9
All Types	All Groups	1703.0	4410	2.6

High Type: Bituminous surface on concrete, concrete, and all types macadam.

Intermediate Type: Gravel mixed-in-place and surface treated gravel.

Low Type: Gravel.

Excessive curves on highways surfaced with high and intermediate type surfaces are considered more dangerous because of the greater traffic volumes and higher speeds prevalent on these highways. Table 5 shows that curves in excess of 7 degrees occur quite frequently, even on heavily-travelled roads. On the 68 miles of high type surface carrying from 2,000 to 3,000 vehicles per day, for example, there are 97 such curves, or an average of 1.4 per mile.

Grades

The decreased speed of heavily loaded trucks on steep grades causes exasperating delays to the free movement of faster traffic because the road is frequently visible for only a short distance ahead, and it is not safe to pass such slow moving vehicles. Even with improved sight distance the situation will not be entirely remedied since opposing traffic will frequently prevent passing.

Studies recently made by the Public Roads Administration indicate that, on a 7 percent grade, a new heavy truck with a load of 20,000 pounds cannot travel faster than about 20 miles per hour, even though expertly handled.

SHARP CURVES

Curves cause traffic to slow down in order to travel safely.

A grade of 7 percent is considered the maximum allowable on new State Highway construction in Vermont, except that 8 percent is permitted if a minimum of 1,000 feet of sight distance is available.

On our rural State Highway System there are 551 places where the grade is steeper than 7 percent, 157 of which are situated on high type surfaces. Of this latter group 81 have traffic volumes of 1,000 or more vehicles per day and 17 of these occur on 68 miles of highway which is carrying a traffic volume of 2,000 or more vehicles per day. On 119.4 miles of intermediate type surfaces there are 30 grades in excess of 7 percent carrying 1,000 vehicles per day or more. (See Table 6, page 22.)

As it is impossible to eliminate all of the grades over 7 percent in Vermont another solution to the problem must be found. The construction of a third lane for the slow moving vehicles would alleviate the situation somewhat. Under such conditions traffic is permitted freer movement.

TABLE 6.

EXCESSIVE GRADES ON THE RURAL STATE SYSTEM

Surface Type	Average 24-hour Traffic (1937) Vehicles	Miles	Grades in excess of 7 percent Number	Number per mile
High	0 - 299	21.7	2	0.1
	300 - 599	50.9	22	0.4
	600 - 999	115.9	52	0.4
	1000 - 1999	213.0	64	0.3
	2000 - 2999	68.0	17	0.3
	3000 & over	7.1	-	-
	All Groups	476.6	157	0.3
Intermediate	0 - 299	72.6	16	0.2
	300 - 599	237.6	46	0.2
	600 - 999	219.2	59	0.3
	1000 - 1999	119.4	30	0.3
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	648.8	151	0.2
Low	0 - 299	398.9	200	0.5
	300 - 599	174.5	43	0.2
	600 - 999	4.2	-	-
	1000 - 1999	-	-	-
	2000 - 2999	-	-	-
	3000 & over	-	-	-
	All Groups	577.6	243	0.4
All Types	All Groups	1703.0	551	0.3

High Type: Bituminous surface on concrete, concrete, and all types macadam.

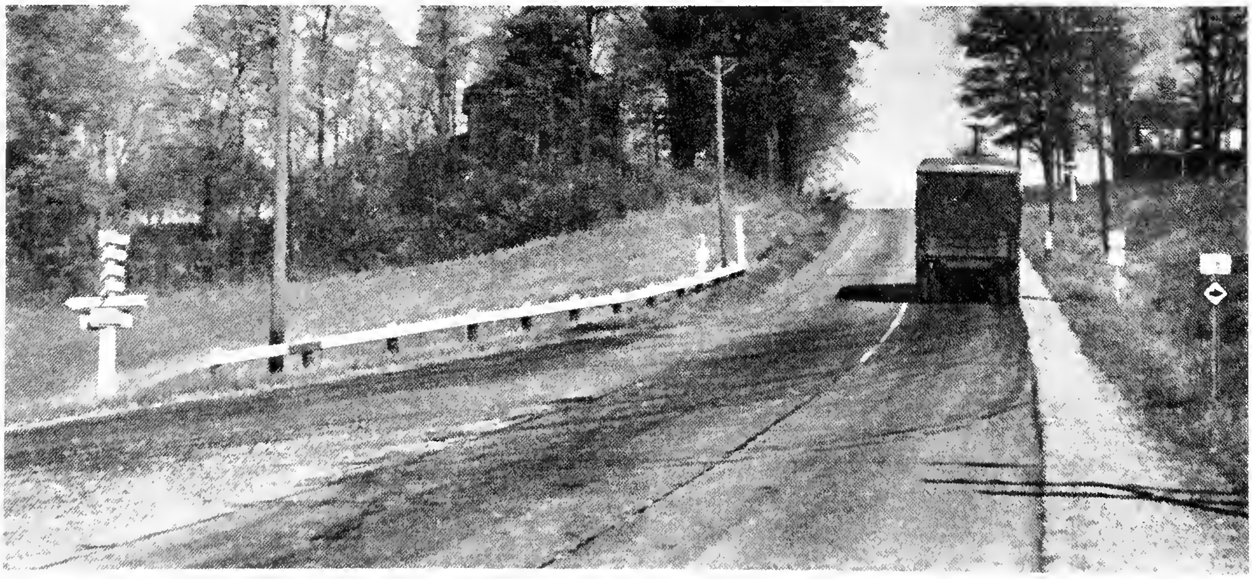
Intermediate Type: Gravel mixed-in-place and surface treated gravel.

Low Type: Gravel.

Surface Width—Two Lanes

The adequacy of the width of a road surface is dependent almost entirely on the volume and character of traffic, or on the number of passings to be expected and whether these passings are predominantly those of passenger cars or whether a relatively large number of commercial vehicles are included.

Studies by the Public Roads Administration indicate that 18-foot surfaces are too narrow for the present day traffic. For example, it was noted in experiments that a number of vehicles passing each other in the same direction on 18-foot surfaces ran with the left wheels on the dirt shoulders. When meeting a large truck on an 18-foot surface, there is a definite sense of restriction. On new construction on the Federal-aid System throughout the country a minimum surface width of 20 feet is now the general rule, and in many States where traffic volumes are large, 22 feet is the minimum.



A NARROW SURFACE WIDENED TO 22 FEET

On main highways 18-foot surfaces are no longer adequate.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

No State Highway should be provided with less than two traffic lanes of 10 feet each to accommodate normal travel. For roads with very light traffic volumes, such as those of the town system, narrower surfaces are generally satisfactory.

Recent technical analyses of this element of highway design by the Design Committee of the American Association of State Highway Officials indicate that surfaces should be at least 20 feet wide in order to accommodate normal peak traffic volumes of 100 vehicles per hour.

To widen all two-lane pavements of less than 20 feet with permanent construction at the present time would not be economical. On the lower traffic volume roads 18-foot pavements will continue to serve fairly satisfactorily. On high volume highways narrow pavement lanes are hazardous and should be widened under maintenance programs with bituminous shoulder treatment unless the entire surface is to be reconstructed in the near future.

Vermont has recognized the fact that 18-foot surfaces are too narrow for the heavily travelled roads of the State and has specified a standard width of 20 feet for surfaces and 6 feet for each shoulder on all highways carrying 1,000 vehicles or more per day. In some cases where the traffic warrants, the shoulders are bituminous treated. This gives a hard surface width of 32 feet which should adequately serve traffic for the next ten years. (Figure 5 shows the increases of surface and roadway design widths from 1892 to 1940, and the forecasted design widths of 1950.)

On the rural State System in Vermont there are 1,210.2 miles of highways having a surface width or pavement width of less than 20 feet. Of this, 55.0 miles have a surface width of 16 feet or less and carry less than 300 vehicles per day. All but 0.7 miles of this mileage is on gravel roads. Of the mileage having a surface width of less than 20 feet, 333.0 miles are carrying 1,000 vehicles per day or more and this mileage is scheduled for widening in the near future. (See Table 7, page 23.) Approximately 90 miles of this has been widened temporarily by the construction of bituminous-mix shoulders. This does not, however, completely solve the problem as in many places the guard rail is only from 2 to 3 feet from the edge of the pavement and this condition does not permit a vehicle to utilize the widening with safety. In order to take care of the situation with complete satisfaction it will be necessary to widen the entire road bed. However, the temporary widening does increase the efficiency of the highway and reduces maintenance cost on shoulders. There is also a considerable mileage of surface treatment on shoulders which is not classed as widening because it is placed there primarily for the purpose of preserving the shoulders.

On high volume roads it is necessary to provide shoulder widths sufficiently wide and stable to encourage vehicle operators to leave the travelled way when stoping because of trouble or making emergency turnouts. Such provision will eliminate potential menaces to other traffic and will provide safety to the operators themselves.

TABLE 7.

MILEAGE OF THE RURAL STATE SYSTEM, CLASSIFIED BY SURFACE WIDTHS AND BY TRAFFIC VOLUME GROUPS.

Surface Type	Average 24-hour Traffic (1937)	Pavement or Surface Width in Feet: 16 & Under	18	20	22	24	Over 24	All Widths
High	0 - 299	-	16.6	5.1	-	-	-	21.7
	300 - 599	-	41.7	9.2	-	-	-	50.9
	600 - 999	-	88.4	27.5	-	-	0.1	116.0
	1000 - 1999	-	197.6	15.2	-	-	0.1	212.9
	2000 - 2999	-	64.0	4.0	-	-	-	68.0
	3000 & over	-	6.6	0.5	-	-	-	7.1
	All Groups	-	414.9	61.5	-	-	0.2	476.6
Intermediate	0 - 299	0.7	43.5	22.1	-	6.3	-	72.6
	300 - 599	-	141.3	86.8	-	9.6	-	237.7
	600 - 999	-	159.9	53.4	-	2.5	3.4	219.2
	1000 - 1999	-	64.8	52.7	0.9	-	0.9	119.3
	2000 - 2999	-	-	-	-	-	-	-
	3000 & over	-	-	-	-	-	-	-
	All Groups	0.7	409.5	215.0	0.9	18.4	4.3	648.8
Low	0 - 299	54.3	195.9	137.8	5.2	5.7	-	398.9
	300 - 599	-	134.1	33.8	-	6.6	-	174.5
	600 - 999	-	0.8	3.4	-	-	-	4.2
	1000 - 1999	-	-	-	-	-	-	-
	2000 - 2999	-	-	-	-	-	-	-
	3000 & over	-	-	-	-	-	-	-
	All Groups	54.3	330.8	175.0	5.2	12.3	-	577.6
All Types	All Groups	55.0	1155.2	451.5	6.1	30.7	4.5	1703.0

High Type: Bituminous surface on concrete, concrete, and all types macadam.
Intermediate Type: Gravel mixed-in-place and surface treated gravel.
Low Type: Gravel.

Multiple Lane Highways

When traffic volumes increase to a point where the passing of vehicles moving in the same direction is seriously hindered, if not almost prohibited by approaching traffic, the capacity of a given road has been reached and the situation becomes intolerable. Sometime before this situation appears, provision must be made to provide an additional traffic lane or lanes.

At the present time all Vermont's rural highways consist of two-lane highways. A small mileage of three-lane highway has been constructed in the urban districts. In estimating the volume of traffic at which it is desirable to consider multiple lane highways, several factors must be taken into consideration. The major factor governing the number of lanes necessary is the congestion factor, or the number of vehicles travelling during certain peak hours, rather than average daily traffic.

Preliminary results of the highway capacity studies conducted by the Public Roads Administration in several States reveal that as the density of traffic on a highway increases, the freedom of movement decreases at nearly a constant rate. These studies indicate that on roads of good alignment with 200 vehicles per hour travelling in each direction, 52 percent will feel some effects of congestion; with 300 vehicles per hour the figure becomes 62 percent; with 400 it becomes 70 percent, and so on until 90 percent of the vehicles are affected when the volume becomes 1,000 vehicles per hour in each direction.

The extent to which a road may be allowed to become congested before steps are taken to widen or otherwise increase its capacity will naturally depend on the availability of funds for such work. A State with adequate funds might decide that when half of the drivers feel the effect of congestion the time has arrived for widening. A State with less adequate funds might set the figure higher. But it is considered that a figure of 70 percent is an absolute limit, which results in a figure of 800 vehicles per hour, in both directions, as the maximum traffic volume of a two-lane road of the best alignment may be expected to carry without intolerable congestion.

Few of the roads in Vermont meet these alignment conditions. In most instances curves or restricted sights or both tend to produce intolerable congestion at an hourly volume somewhat under the figure of 800 vehicles. **Preliminary studies here in Vermont of existing two-lane roads indicate that State Highways carrying 4,000 or more vehicles per day with normal hourly distributions should be considered for widening to multiple lane pavements.**

There now exist about 9 miles of State Highways in Vermont upon which traffic volumes are expected to nearly reach or to exceed 4,000 vehicles per day by 1950. In any improvement of these sections, it would be wise to provide for the construction of multiple lane pavements at some future date, even though the initial construction is only two lanes. In other words, the right-of-way, bridges, and possibly the road bed should be sufficiently wide for a multiple lane road, since it is anticipated that the surface must be widened to more than two-lanes in the not very distant future. (See Table 8, page 25.)

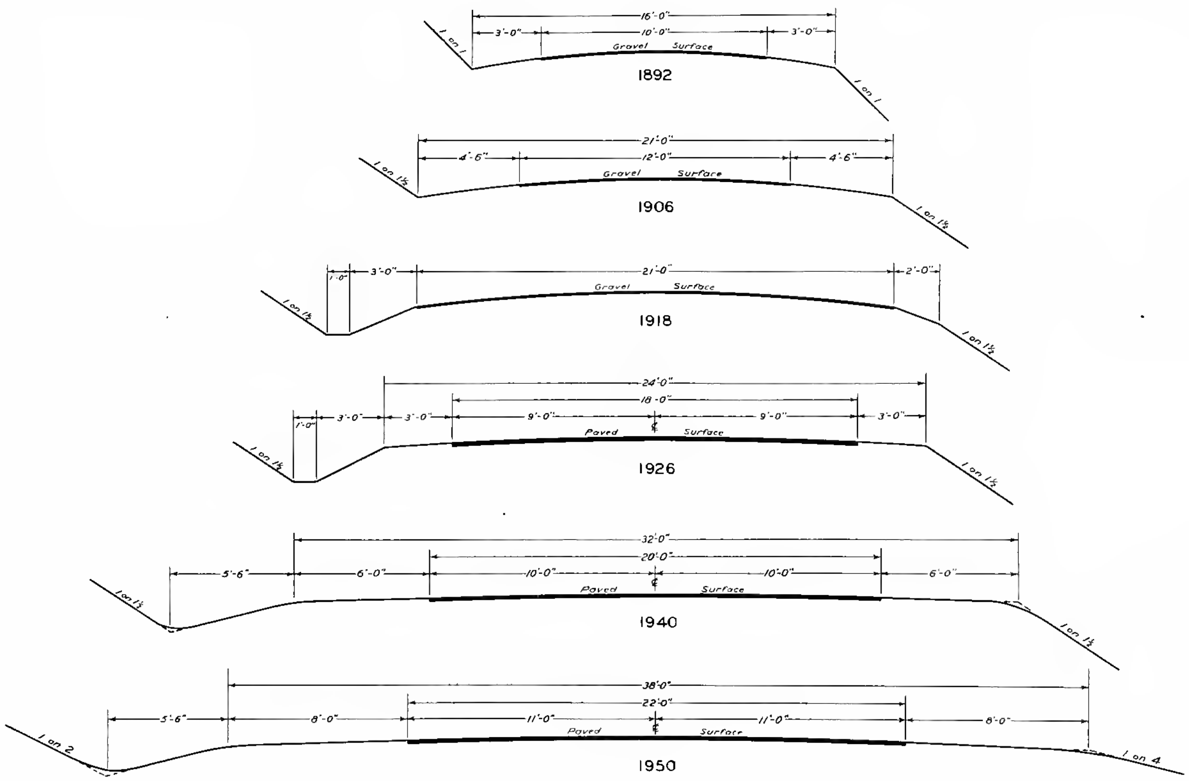


FIGURE 5
CROSS-SECTIONS SHOWING EVOLUTION OF DESIGN
OF SURFACE AND SHOULDER WIDTH
ON THE STATE HIGHWAYS
1892 - 1940 .... HISTORIC
1950 .... FORECAST

TABLE 8.

SECTIONS OF THE RURAL STATE SYSTEM WHICH SHOULD HAVE MULTIPLE LANES BY 1950

Route	Location	Miles	Traffic	Estimated Traffic	
				1945	1950
U. S. 2	Burlington City line east to intersection Vt. 116 (to Hinesburg)	0.876	3,100	4,050	4,500
U. S. 2	From intersection Vt. 116 (to Hinesburg) east to the South Burlington-Williston town line	2.034	2,600	3,400	3,770
U. S. 2	From the South Burlington-Williston town line east to intersection Vt. 116 (to Essex Jct.)	1.416	2,500	3,280	3,620
U. S. 4	Rutland City line west to intersection of Vermont 3 (to Proctor)	0.227	4,000	5,250	5,800
U. S. 4	From intersection Vt. 3 (to Proctor) west to West Rutland village	1.661	3,100	4,050	4,500
U. S. 7	Bennington village line north to intersection Vt. 67-A (to North Bennington)	0.756	3,700	4,850	5,360
U. S. 7	Rutland City line south to North Clarendon village	1.675	3,200	4,180	4,650
	Total Miles	8.645			

SURFACE TYPES

The adequacy of surface types is also largely dependent upon the type and volume of traffic. The experience in this State indicates that highway construction of a type capable of satisfactorily withstanding the winter weather and frost action is also adequate for the loads and the traffic volumes found on Vermont's heavier travelled highways at the present time, or which may be reasonably expected in the near future.

The development of surface on roads in Vermont was initiated with the plank roads of the turnpike companies, but most of the mileages at that time was composed of natural earth. Subsequently, most of the surfacing was done with gravel which is abundant locally in most all parts of the State. When traffic became heavier, faster and more frequent, this type of surface became obsolete for main highways and expensive to maintain. On the State System, and particularly on the higher traffic volume roads, it has been replaced largely with higher types of surface.

The type of surface economically justified for a particular highway depends upon a number of factors, including traffic volume, frequency of heavy wheel loads, nature of sub-grade, availability of local materials, maintenance cost per mile per year, and comparative cost to vehicle operator of driving on each type. The question has been studied by the Design Committee of the American Association of State Highway Officials and others, and it has been found impractical to recommend surface type standards for nation-wide adoption because of differences in climatic conditions, nature of the soil, cost and availability of construction materials, and for other reasons.

In Missouri, an analysis was made in an effort to determine the type of surface which would result in the lowest total cost, including both road cost and vehicle cost, for roads in different traffic volume groups.[1] As a result of this analysis, the following traffic volume limits were recommended for each type:

Surface Type	*Average Daily Traffic During Life of Surface*
Granular	Up to 150
Intermediate	150-599
High-intermediate	600-900
High Type	Over 900

The California Division of Highways, on the other hand, recommends low type surface for traffic up to 250 vehicles per day; intermediate type for traffic from 250 to 1,000 vehicles per day; either high or intermediate type, depending on conditions, for traffic from 1,000 to 2,500 vehicles per day; and high type for traffic over 2,500 vehicles per day.[2]

The fact that higher traffic volume limits are recommended for each type in California than in Missouri is probably due largely to differences in climate and soils. The arid climate and sandy soils in large portions of California undoubtedly permit higher traffic volumes to be carried on the lower types of surface than is possible in Missouri.

In Vermont, the small mileage of some surface types and limited records of maintenance costs for each type in relation to traffic volume preclude the possibility of drawing any definite conclusions concerning traffic volume limits for each type. But the severe winters in this State require the construction of relatively thick base courses, regardless of traffic. Both traffic volume and the frequency of heavy axle loads are low in Ver-

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[1] Special report on Missouri State Highway Needs, 1939. Prepared by Missouri Highway Planning Survey (p. 24).

[2] Highway Facts developed from the California State-Wide Planning Survey, 1939 (p. 52-54).

FIGURE 6

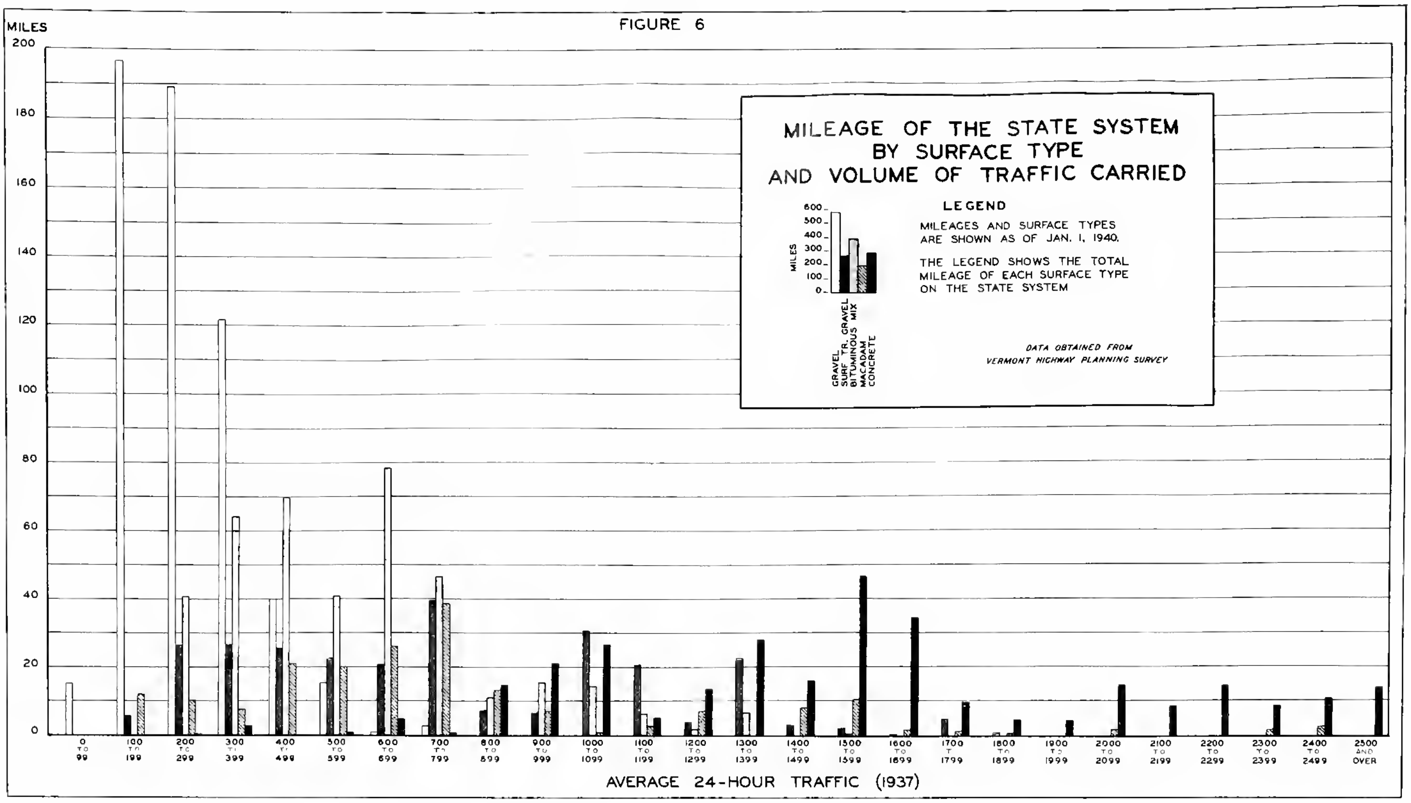
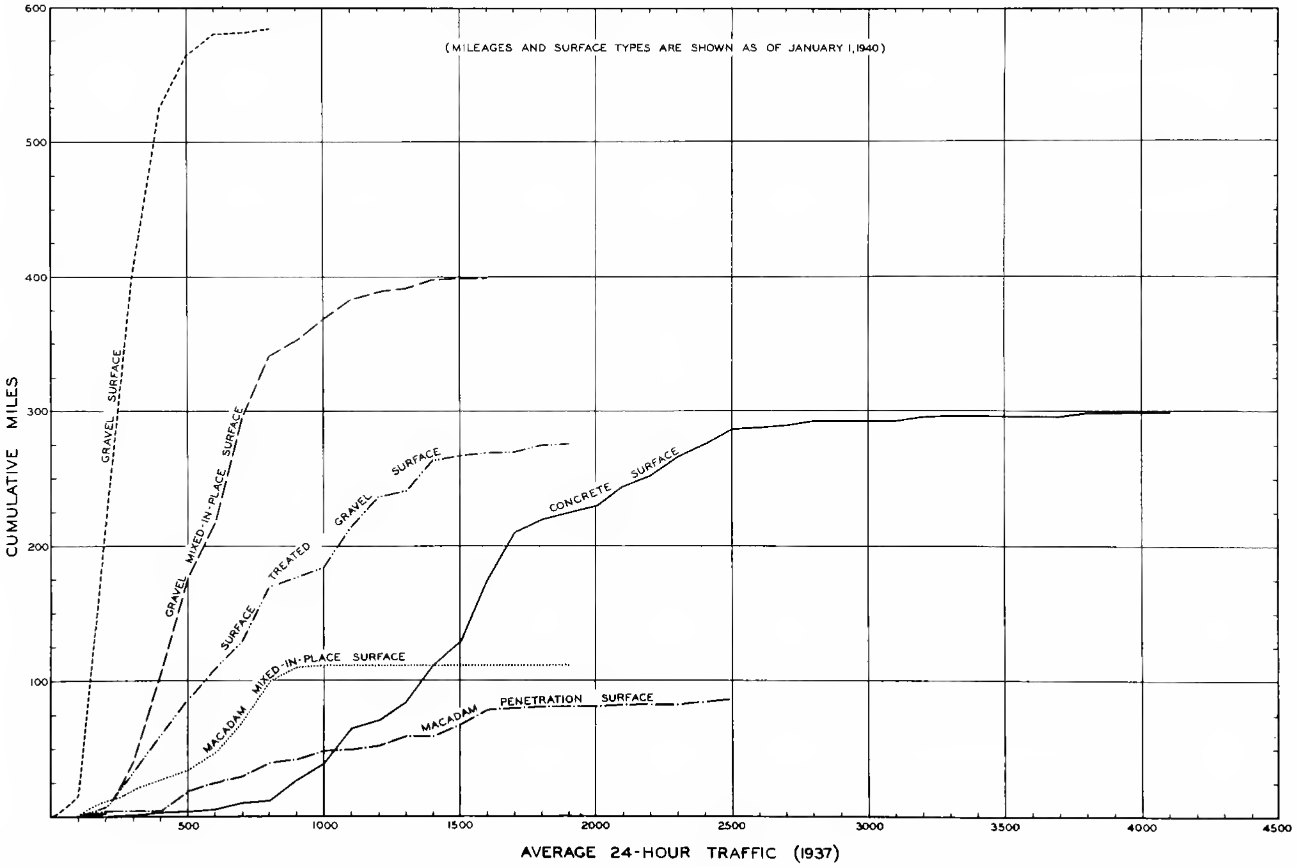


FIGURE 7

SURFACE TYPES BY TRAFFIC VOLUME AND CUMULATIVE MILES ON THE VERMONT STATE HIGHWAY SYSTEM



mont in comparison with other States and serious damage to roads is caused more frequently by frost than by traffic. It is true, however, that traffic volume does have a definite bearing on maintenance costs.

From an analysis of maintenance costs on a selected mileage of roads over the last five years, it is apparent that for roads carrying 300 vehicles per day or more, superior to gravel surface types have considerably cheaper maintenance costs. **Therefore, it appears reasonable to consider 300 vehicles per day as the upper limit for gravel roads in Vermont.** Those carrying higher traffic volumes should be converted to a higher type as rapidly as funds are available.

In Vermont, surface-treated gravel roads are carrying traffic volumes as high as 1,800 vehicles per day, although the mileage of the highest traffic volume roads is not large. At present, surface-treated gravel roads are used extensively up to 1,400 vehicles per day. (See Figure 6, page 26.) Maintenance costs on these roads are relatively high, being almost as high as those for plain gravel for the same amount of traffic. Gravel mixed-in-place roads are shown in this same figure to cover practically the same range of traffic volumes as do the surface-treated roads, and have about two-thirds of the maintenance costs of gravel roads. (See Figure 11, page 52.) This overlapping in service is caused by the expediency of the construction program prior to 1931 when it was necessary to surface many miles of roads without proper base construction. This surface-treated gravel is largely being replaced with gravel mixed-in-place or higher types. But owing to its low construction costs it might serve as an economical surface for traffic volumes from 300 to 1,000 vehicles per day until such time as more funds are made available for surfacing low volume roads with higher types of surface. **It would appear that the gravel mixed-in-place surface is a good type for traffic volumes from 500 to 1,600 vehicles per day. Beyond this volume the higher types of pavements, such as concrete and macadam penetration, appear to**

TABLE 9.

MILEAGE OF THE STATE SYSTEM CLASSIFIED BY SURFACE TYPES AND BY TRAFFIC VOLUME GROUPS

Average 24-hour Traffic (1937)	Surface Type							Total All Types
	Gravel	Surface Treated Gravel	Gravel Mixed-in-Place	Macadam Mixed-in-Place	Macadam Penetration	Bituminous Surface on Concrete	Concrete	
Vehicles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles
0 - 99	15.5	-	-	-	-	-	-	15.5
100 - 199	196.9	6.1	0.2	9.2	3.0	-	-	215.4
200 - 299	189.5	26.7	41.0	10.0	0.4	-	0.1	267.7
300 - 399	121.7	26.7	64.2	7.5	0.7	-	2.7	223.5
400 - 499	40.2	25.8	70.0	7.2	13.9	-	0.2	157.3
500 - 599	15.5	22.9	41.2	13.2	6.9	-	2.0	101.7
600 - 699	1.5	21.1	78.4	22.3	4.2	-	4.9	132.4
700 - 799	3.1	39.9	46.6	29.4	9.2	0.1	1.0	129.3
800 - 899	-	7.7	11.2	10.8	2.9	-	15.1	47.7
900 - 999	-	7.1	15.3	1.0	6.4	-	11.8	41.6
1000 - 1099	-	30.7	14.8	-	0.9	-	26.9	73.3
1100 - 1199	-	21.2	6.2	-	2.9	-	5.2	35.5
1200 - 1299	-	4.2	2.0	-	7.1	-	13.5	26.8
1300 - 1399	-	22.6	6.8	-	-	-	28.3	57.7
1400 - 1499	-	3.4	0.1	-	8.6	-	16.0	28.1
1500 - 1599	-	2.2	0.6	-	10.4	-	46.7	59.9
1600 - 1699	-	0.6	-	-	1.9	-	34.6	37.1
1700 - 1799	-	5.6	-	-	1.1	-	10.1	16.8
1800 - 1899	-	1.1	-	0.5	-	-	4.6	6.2
1900 - 1999	-	-	-	-	-	-	4.6	4.6
2000 - 2099	-	-	-	-	1.9	-	14.7	16.6
2100 - 2199	-	-	-	-	-	-	8.6	8.6
2200 - 2299	-	-	-	-	-	-	14.7	14.7
2300 - 2399	-	-	-	-	1.7	-	8.8	10.5
2400 - 2499	-	-	-	-	2.7	-	10.5	13.2
2500 - 2599	-	-	-	-	-	-	1.4	1.4
2600 - 2699	-	-	-	-	-	-	2.0	2.0
2700 - 2799	-	-	-	-	-	-	3.5	3.5
2800 - 2899	-	-	-	-	-	-	-	-
2900 - 2999	-	-	-	-	-	-	-	-
3000 - 3099	-	-	-	-	-	-	-	-
3100 - 3199	-	-	-	-	-	-	2.5	2.5
3200 - 3299	-	-	-	-	-	1.2	0.5	1.7
3300 - 3399	-	-	-	-	-	-	-	-
3400 - 3499	-	-	-	-	-	-	-	-
3500 - 3599	-	-	-	-	-	-	-	-
3600 - 3699	-	-	-	-	-	-	-	-
3700 - 3799	-	-	-	-	-	-	2.7	2.7
3800 - 3899	-	-	-	-	-	-	-	-
3900 - 3999	-	-	-	-	-	-	-	-
4000 - 4099	-	-	-	-	-	-	0.2	0.2
All Groups	583.9	275.6	398.6	111.1	86.8	1.3	298.4	1755.7
Percent	33.3	15.7	22.7	6.3	4.9	0.1	17.0	100.0

give more satisfactory and economical service. (Figure 7 shows the cumulative miles of various surface types classified according to traffic volumes.)

According to the traffic forecasts, an increase of 45 percent can be reasonably expected by 1950. This means that a gravel road now carrying over 200 vehicles per day should be considered for surfacing to a higher type within the next ten-year period. There now are 371.5 miles of gravel road carrying over 200 vehicles per day and 182.0 miles of this are carrying over 300 vehicles per day. (See Table 9.) (Approximately 42 miles of the 371.5 miles have already been programmed.) A gravel surface should adequately serve the remaining 212.4 miles which now carry less than 200 vehicles per day.

Of the 275.6 miles of surface-treated gravel, 137.1 miles were constructed without adequate base and drainage due to lack of funds and the urgent need of providing a better than gravel surface. Much of this mileage has poor alignment and many excessive curves and grades. These road sections are for the most part in the high traffic volume groups and should be replaced within the next ten years. There are also 43.6 miles of surface-treated gravel which has been constructed on a good base with improved alignment and grade, but which at the present time is inadequate for the volume of traffic carried and needs to be replaced with a higher type of surface.

CONGESTION IN URBAN AREAS

Since the early twentieth century and the advent of the automobile, the character of highway travel has changed tremendously. It has changed from a purely local movement to an intertown and State-wide movement, and at the same time increasing amounts of interstate and cross-state travel have developed.

The free movement of traffic is hampered considerably in many built-up areas. While rural roads have been relocated to meet the needs of modern traffic, city streets, carrying much through traffic, largely remain as they were before the advent of the automobile.

The automobile has proved itself capable of safe operation up to speeds exceeding 60 miles per hour where roads are well designed. Yet, in our cities throughout the country the average speed that motorists can maintain on streets is less than 17 miles per hour. This is not primarily because of legal restrictions, but because of the congestion found on these streets. Streets congested with motor vehicle traffic are poor business locations. Narrow streets in business areas prevent free movement of traffic even more than do narrow roads and bridges in rural areas.

To relieve congestion, provision should be made for off-street parking facilities so as to permit more space for travel in the street. Belt-line or alternate routes may also be constructed to remove through traffic from the congested areas. Such programs should necessarily include the development of access streets to the shopping or business areas from and to any alternate routes.

In many actual instances, business has prospered by adopting such a program for traffic. A motorist forced to travel through congested city streets is thinking mainly of getting through with the least inconvenience possible and is no mood to stop for buying, especially if parking space is difficult to find. The time and motor vehicle operating cost saved by avoiding stop-and-go-city driving are important factors and leave more time and funds for making purchases not related to driving necessities. Municipalities should give some consideration to this problem of parking and selection of alternate routes in order that better service may be accorded not only to traffic which stops, but also to through traffic.

Although Vermont is not a populous State with large urban developments, there are several areas where congestion on city streets should be relieved within the next ten years to permit free movement of motor vehicles through them or around them. Such conditions exist in and near Barre and Burlington.

CENTRAL ROUTE

The General Assembly of 1937 passed an Act authorizing the construction of a central State route which would extend through the central portion of the State from Massachusetts to the Canadian border.

This proposed route would utilize State Highways, State-aid Highways and Town Highways forming connecting links in such a route. The funds for this work are to be taken from the amounts that are allotable to the district through

which the route passes. Such a route would afford better access to the central portion of the State, relieve congestion on routes U. S. 5 and U. S. 7 and provide a scenic route where camping and picnic grounds would be established. It is proposed to include the construction of this route in the present ten-year program, if funds are available.

The main portion of the law regarding this central route is as follows:

> **Central Route: Massachusetts to Canada. (1937 No. 108.)**
>
> Section 1. Additions to State Highways. "The state highway board with the approval of the governor is hereby authorized to make plans for, lay out, locate, construct, maintain, repair, widen, grade and improve as part of the state highway system **a central route extending through the central portion of the state from Massachusetts to the Canadian border.** Such route shall utilize highways belonging to the state highway system, or eligible to be taken over under the provisions of section 4694 of the Public Laws, but the board with the approval of the governor and of the selectmen of the town in which such highway is located may take over as part of the state highway system an unimproved highway forming a connecting link in such route, and such highway when so taken over shall be subject to all the provisions of chapter 200 of the Public Laws. The highway board shall use for such purpose such funds as are fairly allotable to the District through which such Route shall pass on the equitable distribution of the funds available for the State Highway System."

Such a route would be approximately 197 miles in length and would utilize 125.6 miles of State Highway, 59.3 miles of State-aid Highway and 11.9 miles of Town Highway. (See Map 2 in the Appendix.) Of the 125.6 miles on the State System 58.8 miles would be included in any future construction program, regardless of the central route, because of high alignment indices or deficient surface types; 59.3 miles are adequate for the present and 7.5 miles, although below the present State standards, would not be improved for some time to come because of the low traffic volume. On the basis of constructing a central route, however, the 7.5 miles of State Highway mentioned above, 56.6 miles of State-aid Highway and 11.9 miles of Town Highway making a total of 76 miles, would be included in any future construction program if funds were available. This 76 miles is in addition to the 58.8 miles of State Highway requiring reconstruction in any event.

STATE HIGHWAY DEFICIENCIES

The preceding discussion of the elements in highway design and the comparison of the present status of Vermont State Highways with standard elements illustrates several reasons why it is necessary to reconstruct, widen, and modernize many of our present highways. A road is inadequate when conditions in alignment, curvature, grades, surface widths, and surface types impede the free and safe movement of traffic. And in any construction program, it is logical first, to improve road sections having elements which vary most from standards permitting free traffic movement.

In order to determine those sections of highways which are inadequate, an analysis was made of the physical characteristics of each section in relation to traffic. By comparing restricted sights, excessive curves, excessive grades, surface widths, surface types, and traffic volumes, it has been possible to assign indices, or ratings, to each section of the State Highway System, which express the relative inadequacy of the section in each of the several particulars. There are many sections of highway which have poor alignment and grade, but which because of the low traffic volume at the present time, will not show any immediate need for improvement. A listing of road projects in the order of one index, from high to low, results in a schedule of projects rated according to relative deficiency in the particular represented by the index. Such listings do not, in themselves, constitute construction programs. While relationships between the factors used have been tested and are believed to be reasonably correct, a mathematical analysis cannot be expected to be satisfactory as a substitute for engineering judgment, but can only be regarded as an effective aid thereto. The most that can be accomplished in such an analysis is to present the facts and their interrelationships in such a way as to narrow the field in which judgment need be exercised, and to permit the making of decisions in a consistent manner.

Alignment Index (Sight Distance, Curves, Grades)

The ratings of the various sections of State Highway with respect to their comparative deficiencies were determined by finding out how each varied from the average condition.

The average condition of the State System as regards sight distance, curvature, and grade in relation to traffic volume is represented by an index of 1.0. This is called an alignment index, because the deficiencies accrue from faults of alignment, either horizontal or vertical. A road section with an index below 1.0 is better than the average State Highway section with respect to sight distance, curvature, and grade; and one with an index above 1.0 is worse than the average in these particulars. There are 283 miles with no objectionable grades, curves, or restricted sight distances and the index for this mileage is 0.0. The total mileage with an index smaller than 1.0 is 1,265 miles. On the other hand, the index is greater than 1.0 for 438 miles and greater than 1.7 for 202.8 miles. The mileage with an index greater than 1.7 is that considered for inclusion in a ten-year construction program. With but a few exceptions it was not considered practical at this time to include those sections of highway having an alignment index of less than 1.7, for two reasons: (1) the mileage with indices of 1.7 and over is estimated to be a sufficient program for the funds available during the next ten years; (2) those sections with indices below 1.7 will serve without serious inconvenience for the time being or until such time as funds are available for their improvement.

The following summary shows the mileage of road with different degrees of alignment deficiency of 1.7 or more:

Alignment Deficiency Index	*Miles*
8.0 and over	1.7
7.0-7.9	3.7
6.0-6.9	6.8
5.0-5.9	9.5
4.0-4.9	19.2
3.0-3.9	42.3
2.0-2.9	82.8
1.7-1.9	36.8
Total	202.8

There are 52.8 miles of this total which are also included in the mileage listed below as inadequate as regards surface type.

Surface Type Index

In analyzing the status of the State System in regard to the adequacy of the existing surface types, it was assumed that a gravel road should be changed to a higher type when the traffic exceeds 300 vehicles per day. Such a road was assumed to have an index of 1.0. The surface type index for each gravel road section was computed by dividing the 1937 average daily traffic by 300. A gravel road carrying 450 vehicles per day in 1937 would, therefore, have an index of 1.5, and one carrying 210 vehicles per day would have an index of 0.7. Since the traffic by 1950 is expected to exceed the 1937 traffic by about 45 percent, a gravel road with a 1937 average daily traffic volume of about 200 vehicles per day should probably be changed to a higher type of surface by 1950. Such a road would have an index of 0.66. The following summary shows the mileage of existing gravel roads with a deficiency of 0.66 or more.

Surface Type Deficiency Index	*Miles*	*Average 24-hour Traffic (1937)*
1.66 and over	4.6	600 and over
1.00-1.65	55.7	400-599
0.66-0.99	311.2	200-399
Total	371.5[1]	

[1] Approximately 42 miles already programmed.

It is difficult to fix a maximum traffic volume limit for surface-treated gravel roads since inadequate base is a more important factor than traffic volume in considering the need for surface type improvement. There are 137.1 miles of surface-treated gravel road with high maintenance costs due mainly to an inadequate base, all of which carries in excess of 500 vehicles per day. Of this, 74 miles are also obsolete because of alignment conditions. There are also 43.6 miles of this type that should be replaced by a higher type of surface because of the volume of traffic carried. This mileage should be improved at the earliest opportunity.

Surface Width Index

In analyzing width deficiencies, it was assumed that an 18-foot surface which carried 1,000 vehicles or more per day in 1937 is too narrow and should be widened. The width index for 18-foot roads was, therefore, determined by dividing the 1937 average daily traffic by 1,000. On this basis there are 333 miles with a width index of 1.0 or more. However, 102 miles of this have an alignment deficiency factor of 1.7 or more and would be included in the program for that reason. The remaining 231 miles should be scheduled for widening.

The locations of the road sections on which these deficiencies are found are plotted on Map No. 1 in the Appendix. Different types of shading indicate different deficiencies. The amount of the deficiency in relation to traffic for any road section is indicated by the distance the shading extends from the road band. Deficiencies in curvature, sight distance, and grade are shown in red. Surface type deficiencies are shown in yellow. Blue indicates a deficiency in width. The wider the bands of these various colors, the greater is the deficiency or inadequacy. The various sections of highway have been combined according to indices into convenient projects and their costs of improvement estimated by the design department. These tabulations are too bulky to be included in this report, but a sample is shown in Table G, pages 77-78, of the Appendix, and the tabulations are on file in the Highway Department.

HIGHWAY STRUCTURES

Bridges

Because of its hilly and mountainous terrain with narrow valleys causing extremely rapid run-off of water during storms, Vermont has an extensive bridge problem. For this reason any highway program must give careful consideration to adequate bridge construction. Many of the existing structures which were built before the advent of heavy motor vehicle traffic are today the weak links in the highway chain.

Prior to 1915 little thought was given to the location of bridges with respect to highway alignment, nor did the requirements of slow horse-drawn vehicles demand capacities for heavy roads. Sharp approach curves, narrow roadways, low clearances and structural weaknesses make these older bridges unsafe for modern traffic conditions especially on main roads. The first attempt to coordinate road and bridge construction was a law passed in 1915 requiring all bridges built with State-aid funds to have a capacity of 15 tons and a roadway width of 20 feet if conditions warranted.

One of the predominating types of bridge built before 1900 was the covered wooden bridge. These are rapidly disappearing on the main highways, but still continue to be adequate on the lesser travelled town highways where they will be preserved as long as possible because of their picturesqueness. Although the trusses of the covered bridge are unusually strong, weak floor systems and serious disintegration at the ends where the wood beams come in contact with the earth make constant repairs necessary. Low clearances, moreover, add to their unsuitability for heavy truck traffic.

Of the older bridges in Vermont, many now have been replaced with more modern structures, and additional new ones have been built to carry safely the loads imposed by motor vehicle traffic. **On the various rural systems there now are 2,093 bridges of 20-foot span or over, together with hundreds of small drainage structures ranging in span from 6 to 20 feet. Many of these are totally inadequate for present conditions, and their modernization as soon as funds become available is important.** Inadequate bridges on main highways have become of special concern to the Federal Government because of the needs of National defense.

Bridges on the State System

To serve traffic properly, the clear roadway of a bridge should be at least four feet wider than the surface of the highway leading up to it. At

NARROW BRIDGE

Passing on narrow bridges is difficult and dangerous.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

Number of Bridges of 20-foot Span and Over on State System Less Adequate Than the Average, Summarized According to Capacity, Width, and Traffic Volume

		Less Than H-15 Lane Loading			*Equal to or Greater Than H-15 Lane Loading*		
		Roadway Width Less Than			*Roadway Width Less Than*		
Number of Bridges	*Average 24-hour Traffic (1937)*	*24′*	*20′*	*18′*	*24′*	*20′*	*18′*
35	1,000 and over	3	1	0	32	1	0
14	500-999	8	6	4	6	1	0
26	Less than 500	20	19	13	6	6	1
	All Groups	31	26	17	44	8	1

(Of these structures, nine have a vertical clearance of less than 14 feet.)

the present time, for all volumes of traffic, bridges constructed with Federal-aid funds are designed with a 24-foot clear roadway. This minimum width is recommended by the American Association of State Highway Officials for all roads carrying over 1,000 vehicles per day. The wide trucks now using the highways make passing on 18- and 20-foot bridges difficult and dangerous, and on 14- and 16-foot bridges impossible. The present Vermont State Highway bridge standards for non-Federal-aid projects specify 20 feet as the minimum roadway width, but this is considered inadequate on highways carrying large volumes of traffic.

Prior to 1900, roads were constructed with surfaces about 8 to 10 feet wide. In the Biennial Report for 1902, the Commissioner of Highways advocated 12-foot surfaces for roads. This allowed for loads which overhung the width of vehicles and improved the facilities for passing. Apparently many bridges constructed even before 1900 had clear roadway widths of from 4 feet to 8 feet wider than the surface of the road leading up to them. Since that date our highways have gradually widened, as traffic has increased, to a 20-foot travelled surface. But the clear roadway width of bridges has not been changed in proportion.

It is also important to the free movement of traffic that the clearance between the roadway surface and any part of an overhead bridge be sufficient for the maximum size of the loads carried. The law limits the height of vehicles in Vermont to 12.0 feet, but most States permit loads and vehicles to have a maximum height of 12.5 feet. In order to allow the movement of traffic carrying loads as high as the law allows, it is necessary to provide at least a 12-foot vertical clearance, and 12.5 feet is provided wherever possible. On Federal-aid bridges a minimum vertical clearance of 14.0 feet is required.

More important than either vertical or horizontal clearance is the ability of a bridge to carry heavily loaded vehicles. At the present time bridges are designed to carry what to the engineer is known as H-15 Lane Loadings.[1] In early years not as high a standard was used at all times, and deterioration of the members has reduced the safe carrying capacity of many old bridges below the present requirement.

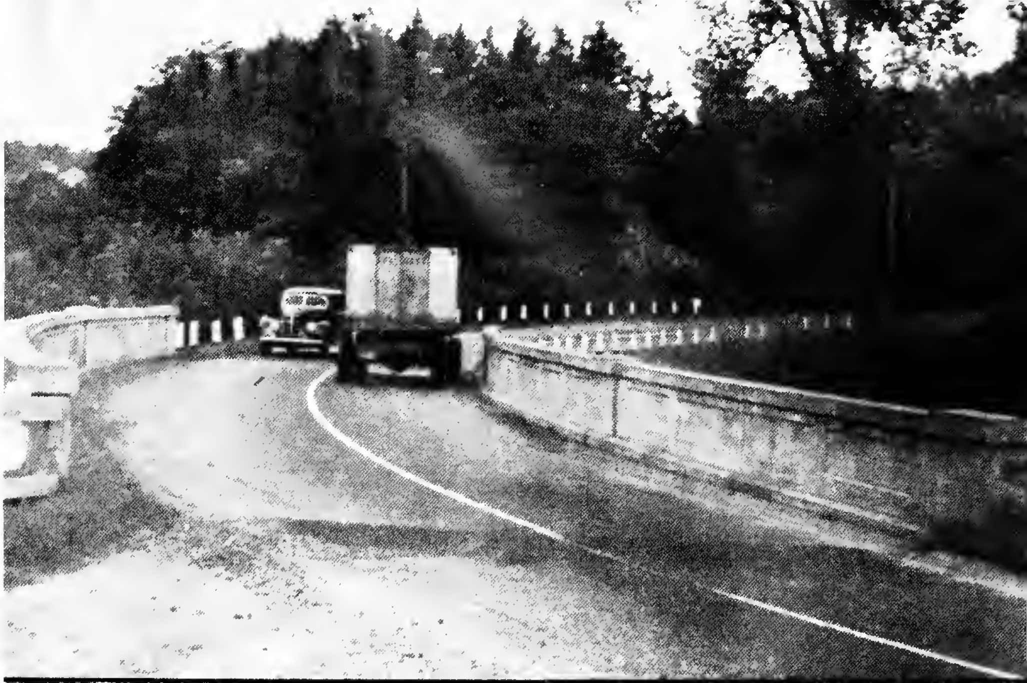
For purposes of determining a schedule of necessary improvement on bridges of 20-foot span length and over on the State Highway System, an index or rating was established for each bridge. This index expresses the relation of several of the more important factors to be considered in bridge construction or improvement, and indicates the relative need of improvement of any one bridge in comparison with all others on the State Highway System and State-aid Connecting Links.

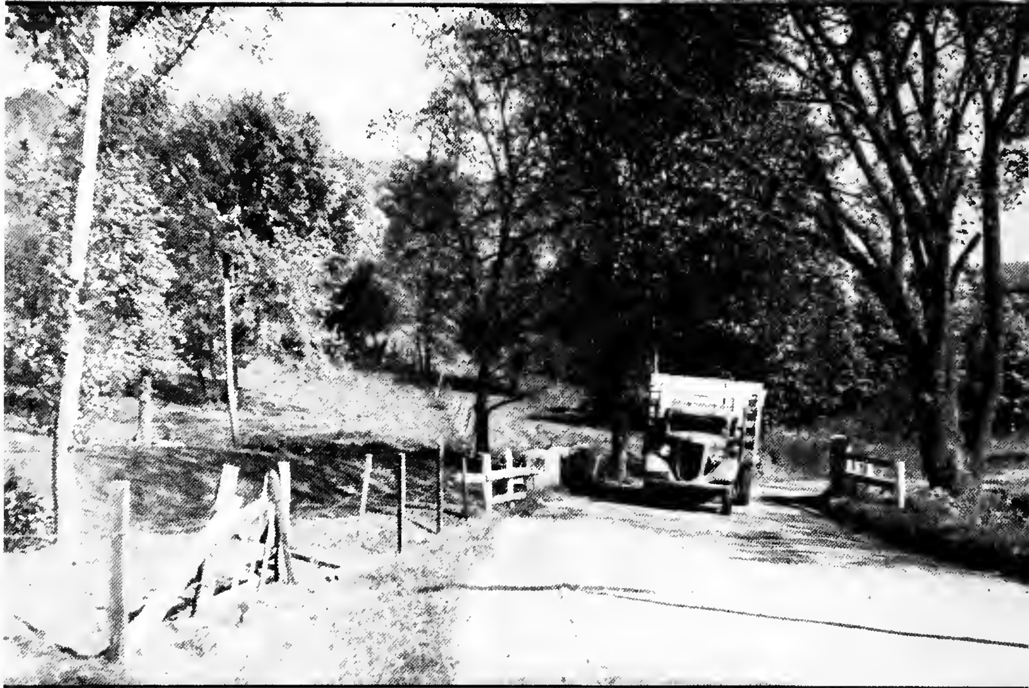
In the development of this index, deficient load carrying capacity was given principal weight, and deficiencies of alignment and roadway width in relation to traffic were considered next in importance. Deficiency ratings were computed for all bridges of 20-foot span length and over, and the average of the 536 structures on the State System was found to be 1.4. **There are 75 bridges that are more deficient than the average.** (See Table 10, page 34.) On Map No. 1 in the Appendix, deficient or inadequate bridges are indicated by means of a blue triangle. The higher the triangle the greater is the degree of deficiency of the bridge.

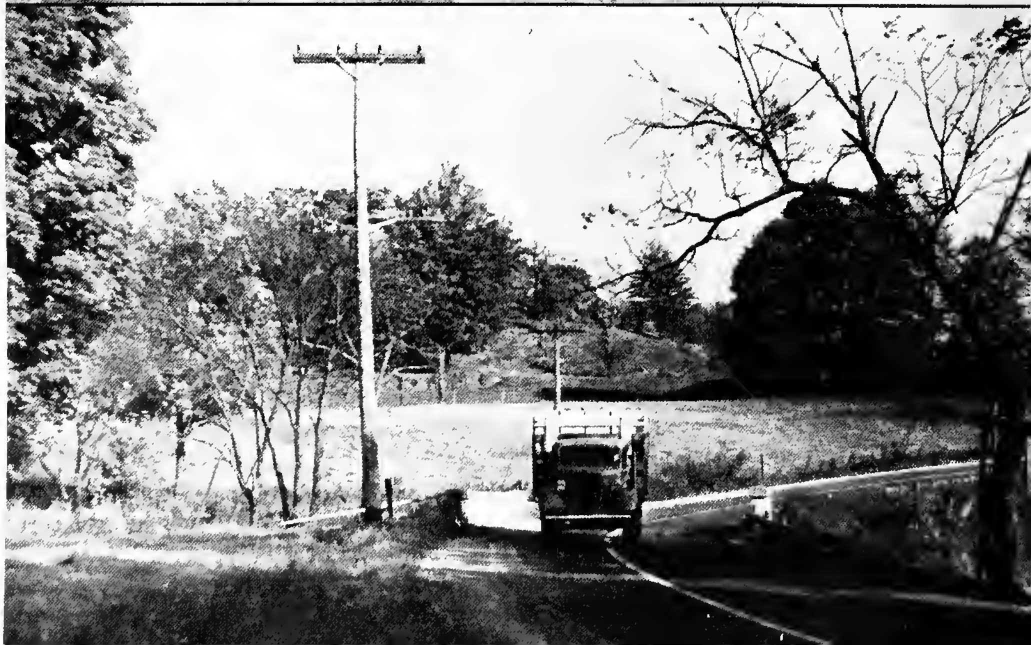
Besides the above listed structures, there are 60 on the State System having a roadway width of less than 24 feet that carry 1,000 vehicles or more per day. Since 18-foot surfaces carrying this volume of traffic are scheduled to be widened to 20 feet it seems reasonable to widen these bridges to 24 feet so that the bridge may be 4 feet wider than the road.

In addition to the bridges having spans of 20 feet or more, there are 553 smaller structures with spans of 6.0 to 19.9 feet. The present structural characteristics of many of these limit the free movement of traffic. Capacity and width are the restricting factors of these smaller structures on State Highways since there are no restricted vertical clearances.

[1] H-15 Lane Loading is equivalent to a continuous procession of trucks passing on two 10-foot lanes, each procession being made up as follows: A 15-ton truck preceded and followed by a 11¼-ton truck, the trucks assumed to be 30 feet apart and the wheelbase of each assumed to be 14 feet. In each truck the load is assumed to be distributed 20 percent on the front axle and 80 percent on the rear axle.







SHARP CURVE ON NARROW BRIDGE

Sharp approach curves and narrow roadways make these older bridges unsafe for modern traffic on main highways.

TABLE 10.

BRIDGES OF 20-FOOT SPAN OR MORE ON THE STATE SYSTEM LISTED IN THE ORDER OF DEFICIENCY INDEX /1

County	Route	Town	Station /2	HPS No. /3	Type	Span Feet	Loading Capacity	Horizontal Clearance Feet	Vertical Clearance Feet	Year Constructed	Average 24-Hour Traffic 1937 Total Vehicles	Average 24-Hour Traffic 1937 Trucks Vehicles	Average 24-Hour Traffic Estimated 1945 Total Vehicles	Average 24-Hour Traffic Estimated 1950 Total Vehicles	Deficiency Index	Estimated Cost of Improvement
Caledonia	U.S. 5	St. Johnsbury	293 + 03 FA	123	Truss	164	H-12½	18	19	1916	1525	200	1998	2211	17.9	$150,000*
Grand Isle	U.S. 2	N.Hero-Alburg	498 + 84 FA	4	Truss	799	H-12½	14	16	1886	600	55	786	870	15.8	575,000*
Rutland	F-10	Sudbury	28 + 54	178	Covered	141	H-10	14	-	1905	300	40	393	435	14.0	30,000*
Grand Isle	U.S. 2	Gr.Isle-N.Hero	331 + 45 FA	2	Truss	182	H-12½	14	18	1886	700	60	917	1015	13.7	150,000*
Orange	Vt. 113	Chelsea	167 + 20	30	I-Beam	29	H-10	14	-	1910	175	24	229	254	13.5	6,000*
Orange	Vt. 113	West Fairlee	75 + 31	105	I-Beam	30	H-10	14	-	1910	250	36	328	363	13.5	6,000*
Lamoille	Vt. 108	Stowe	279 + 20	108	Truss	50	H-10	14	-	1908	175	-	229	254	13.4	15,000*
Franklin	Vt. 105	Sheldon	358 + 07 FA	120	Truss	332	H-8	15	17	1897	700	100	917	1015	13.2	150,000*
Windham	Vt. 30	Townshend	15 + 63	199	Covered	222	H-10	17	11.5	1865	450	78	590	653	13.2	75,000*
Franklin	Vt. 118	Montgomery	390 + 20	105	Covered	70	H-10	16	11.5	1885	400	45	524	580	13.1	20,000*
Windham	Vt. 30	Newfane	143 + 39	164	Covered	66	H-10	18	12.5	1878	600	82	786	870	13.0	25,000*
Windham	Vt. 8	Jamaica	18 + 50	108	Truss	38	H-10	16	-	1900	175	21	229	254	13.0	20,000*
Orleans	Vt. 12B	Craftebury	306 + 97	66	I-Beam	48	H-10	15	-	1932	200	40	262	290	12.8	12,000*
Franklin	Vt. 118	Montgomery	404 + 44	100	Covered	62	H-10	16	12	1885	400	75	524	580	12.4	17,000*
Franklin	Vt. 118	Montgomery	413 + 09	101	Covered	89	H-10	16	12	1885	400	75	524	580	12.4	18,000*
Lamoille	Vt. 15	Cambridge Vil.	397 + 95 FA	24	Covered	80	H-10	16	12	1870	675	75	884	979	12.4	25,000*
Orange	Vt. 113	Thetford	74 + 19	104	Covered	69	H-10	16	11	1910±	250	36	328	363	12.3	12,000*
Windsor	Vt. 100A	Plymouth	208 + 95	195	I-Beam	29	H-10	17	-	1922	250	31	328	363	11.8	3,500*
Windsor	Vt. 100A	Plymouth	198 + 30	183	I-Beam	35	H-10	17	-	1922	250	31	328	363	11.8	4,500*
Lamoille	Vt. 15	Cambridge	392 + 16 FA	28	Covered	158	H-10	2 @ 12	12	1870	675	75	884	979	11.7	50,000*
Windsor	Vt. 100	Plymouth	219 + 86	182	I-Beam	34	H-10	18	-	1927	210	24	275	305	11.7	3,000*
Orange	Vt. 113A	Thetford	392 + 32	106	Truss	54	H-10	18	-	1908	200	25	262	290	11.7	15,000*
Franklin	Vt. 118	Berkshire	82 + 90	13	Truss	153	H-10	18	16	1908	500	75	655	725	11.5	60,000*
Windsor	Vt. 100A	Plymouth	170 + 90	194	I-Beam	29	H-10	18	-	1922	250	31	328	363	11.3	4,000*
Windsor	Vt. 100	Plymouth	253 + 99	188	I-Beam	34	H-10	18	-	1922	210	24	275	305	11.2	3,000*
Orange	Vt. 113	West Fairlee	121 + 98	155	I-Beam	40	H-10	18	-	1908	200	25	262	290	11.2	10,000*
Chittenden	U.S. 7	Shelburne	199 + 29 FA	81	I-Beam	23	H-12½	20	-	1916	2300	265	3013	3335	11.2	5,000*
Franklin	U.S. 7	Swanton	250 + 61 FA	125	Truss	190	H-12½	20	12	1893	1500	150	1965	2175	11.1	40,000* /4
Windsor	Vt. 100	Plymouth	153 + 35	181	I-Beam	30	H-10	19	-	1910	210	24	275	305	10.7	4,500*
Windham	Vt. 30	Dummerston	78 + 91	44	Truss	56	H-10	20	-	1875	700	90	917	1015	10.4	7,500*
Addison	Vt. 125	Hancock	114 + 75	61	I-Beam	37	H-10	20	-	1928	170	30	223	247	10.1	5,000*
Washington	U.S. 2	Duxbury	5 + 45 FA	30	Truss	244	H-15	20	14.5	1924	2400	253	3144	3480	8.9	40,000
Windham	U.S. 5	Westminster	430 + 50 FA	215	Arch	289	H-15	20	-	1926	1650	202	2162	2393	6.3	100,000*
Addison	U.S. 7	Ferrisburg	261 + 13 FA	33	Girder	179	H-15	22	-	1928	1950	225	2555	2828	5.1	25,000*
Rutland	U.S. 4	Rutland	82 + 24 FA	152	Truss	116	H-15	20	18	1928	3100	375	4061	4495	5.0	14,000
Chittenden	U.S. 7	Shelburne	127 + 21 FA	82	T-Beam	95	H-15	20	-	1926	2300	265	3013	3335	4.4	7,000*
Rutland	U.S. 7	Clarendon	296 + 94 FA	47	Truss	153	H-15	20	17	1928	3200	244	4192	4640	4.2	30,000*
Caledonia	U.S. 2	St. Johnsbury	113 + 99 FA	131	I-Beam	65	H-15	20	-	1939	1300	123	1703	1885	3.8	5,000
Addison	U.S. 7	Salisbury	7 + 35 FA	124	T-Beam	24	H-15	20	-	1918	1250	155	1638	1813	3.7	10,000*
Washington	U.S. 2	Middlesex	298 + 37 FA	87	Truss	303	H-15	20	15	1928	2200	253	2882	3190	3.5	30,000
Rutland	U.S. 4	Fairhaven	179 + 83 FA	6	Arch	156	H-15	20	-	1920	1550	175	2031	2248	3.5	12,000
Windham	U.S. 5	Brattleboro	172 + 85 FA	3	Truss	388	H-15	20	17	1927	2200	230	2882	3190	3.1	75,000

* Included in Proposed Ten Year Program.

1/ Bridges having a deficiency index of less than the average of 1.4 not included.

2/ Stations refer to straight line diagrams. Federal-aid indicated by FA.

3/ Number assigned by Highway Planning Survey.

4/ Cost of improvement included with underpass.

(See pages 72-78 for additional Bridge Tables)

TABLE 10 (CONTINUED)

BRIDGES OF 20-FOOT SPAN OR MORE ON THE STATE SYSTEM LISTED IN THE ORDER OF DEFICIENCY INDEX /1

County	Route	Town	Station /2	HPS No. /3	Type	Span	Loading Capacity	Horizontal Clearance	Vertical Clearance	Year Constructed	Average 20-Hour Traffic				Deficiency Index	Estimated Cost of Improvement
											1937		Estimated			
											Total	Trucks	1945 Total	1950 Total		
						Feet		Feet	Feet		Vehicles	Vehicles	Vehicles	Vehicles		
Bennington	U.S. 7	Bennington	261 + 67 FA	19	T-Beam	33	H-15	20	-	1930	2000	130	2620	2900	3.0	$ 3,000
Orange	Vt. 12	Braintree	46 + 39 FA	21	T-Beam	30	H-15	20	-	1928	650	30	852	943	2.7	23,000*
Rutland	U.S. 7	Pittsford	149 + 55 FA	131	T-Beam	98	H-15	24	-	1931	2400	248	3144	3480	2.6	45,000
Windham	U.S. 5	Guilford	340 + 19 FA	81	T-Beam	48	H-15	20	-	1925	1475	170	1932	2139	2.6	50,000*
Rutland	U.S. 4	Sherburne	85 + 81 FA	168	T-Beam	33	H-15	20	-	1920	700	80	917	1015	2.5	10,000
Windsor	Vt. 12	Woodstock	80 + 78	337	T-Beam	34	H-15	18	-	1920	300	53	393	435	2.4	8,000*
Chittenden	U.S. 7	Milton	268 + 23 FA	312	Truss	310	H-15	20	15	1929	1600	150	2096	2320	2.4	50,000
Caledonia	U.S. 2	St. Johnsbury	313 + 73 FA	139	T-Beam	110	H-15	20	-	1930	1600	160	2096	2320	2.4	5,000
Windsor	U.S. 5	Hartland	72 + 53 FA	317	Girder	137	H-15	20	-	1927	1800	200	2358	2610	2.2	15,000
Franklin	Vt. 105	Berkshire	63 + 00 FA	14	Truss	163	H-15	20	14	1929	650	100	852	943	2.2	15,000
Rutland	U.S. 7	Danby	37 + 74 FA	68	T-Beam	30	H-15	20	-	1927	1300	130	1703	1885	2.1	4,000*
Rutland	Vt. 103	Wallingford	104 + 32 FA	187	T-Beam	54	H-15	18	-	1929	1100	145	1441	1595	2.1	4,000
Orleans	U.S. 5	Barton	358 + 63 FA	20	T-Beam	43	H-15	20	-	1924	1000	145	1310	1450	2.1	5,000
Rutland	Vt. 103	Wallingford	5 + 73 FA	184	T-Beam	53	H-15	20	-	1929	1150	147	1507	1668	2.0	4,000
Rutland	Vt. 103	Wallingford	5 + 10 FA	179	Truss	62	H-15	20	-	1926	1150	147	1507	1668	2.0	10,000
Washington	U.S. 2	Marshfield	93 + 07 FA	801	Slab	23	H-15	20	-	1915	900	100	1179	1305	2.0	2,000
Rutland	U.S. 4	Castleton	249 + 05 FA	28	T-Beam	107	H-15	20	-	1923	2150	271	2817	3118	1.9	8,000
Windham	U.S. 5	Dummerston	210 + 34 FA	41	Arch	39	H-15	20	-	1920	1750	230	2293	2538	1.8	30,000*
Orleans	U.S. 5	Barton	382 + 57 FA	15	Girder	129	H-15	22	-	1926	1000	145	1310	1450	1.8	8,000
Orleans	Vt. 12	Glover	357 + 57	85	I-Beam	30	H-15	18	-	1910	400	70	524	580	1.8	4,000*
Washington	U.S. 2	Waterbury	124 + 92 FA	171	Truss	92	H-15	20	-	1928	1625	250	2129	2356	1.7	25,000
Chittenden	U.S. 2	Colchester-Milton	117 + 88 FA	11	Truss	332	H-15	20	20	1929	900	67	1179	1305	1.7	45,000
Addison	Vt. 30A	Shoreham	291 + 01	136	Slab	23	H-15	17	-	1916	225	38	295	326	1.7	2,000*
Windham	U.S. 5	Putney	169 + 65 FA	177	T-Beam	124	H-15	22	-	1928	1500	184	1965	2175	1.7	7,000
Windham	Vt. 112	Whitingham	23 + 12	222	Arch	26	H-15	19	-	1914	175	20	229	254	1.7	2,000*
Lamoille	Vt. 15	Hyde Park	29 + 00 FA	61	Arch	63	H-15	20	-	1924	1000	135	1310	1450	1.7	5,000*
Chittenden	U.S. 2	Bolton	282 + 18 FA	3	T-Beam	24	H-15	20	-	1929	1600	240	2096	2320	1.6	3,000
Chittenden	U.S. 2	Richmond	65 + 71 FA	78	T-Beam	24	H-15	20	-	1929	1600	240	2096	2320	1.6	1,000*
Rutland	U.S. 4	Rutland	100 + 10 FA	156	I-Beam	52	H-15	20	-	1928	3100	375	4060	4495	1.6	7,000*
Windsor	Vt. 103	Ludlow	304 + 73 FA	164	I-Beam	104	H-15	20	-	1930	1100	147	1441	1595	1.6	12,000*
Addison	Vt. 17	New Haven	194 + 43	89	I-Beam	30	H-15	18	-	1910	600	140	786	870	1.6	4,000*
Addison	Vt. 125	Hancock	201 + 60	58	T-Beam	28	H-15	18	-	1918	170	30	223	247	1.5	2,000*
Windsor	Vt. 11	Chester	95 + 37 FA	103	Truss	80	H-15	18	-	1928	450	60	590	653	1.5	12,000

* Included in Proposed Ten Year Program.

1/ Bridges having a deficiency index of less than the average of 1.4 not included.

2/ Stations refer to straight line diagrams. Federal-aid indicated by FA.

3/ Number assigned by Highway Planning Survey.

The 553 structures having 6.0- to 19.9-foot spans have been classified by the Highway Department as follows:

Class 1. Twenty-six structures are inadequate because of capacity, all of which are less than 24 feet in width, 15 less than 20 feet, and 9 less than 18 feet. Some of these are on poor alignment. (See Table D, pages 72-73, in the Appendix.)

Class 2. There are 27 others which are less than 24 feet in roadway width, 11 of which are less than 20 feet in roadway width, and 4 less than 18 feet. These structures are on poor alignment. (See Table D, pages 72-73, in the Appendix.)

Class 3. There are 384 on good alignment where the roadway width is less than 24 feet. It is possible for vehicles to pass on these structures, but it is a dangerous practice because of the speeds travelled on approaching road sections. There are 37 of these having a roadway width less than 20 feet. (See Table E, page 74, in the Appendix.)

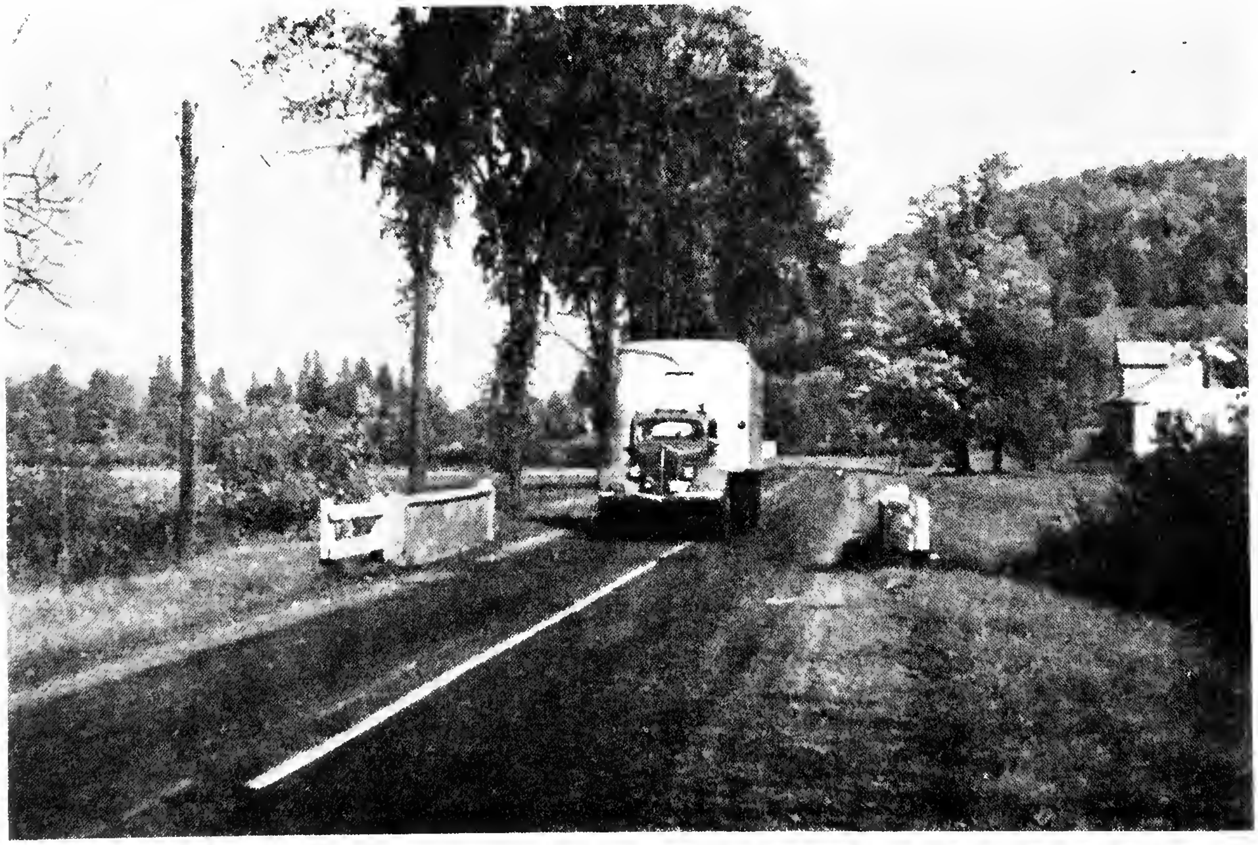
Class 4. There are 116 that are considered adequate in all respects for the free movements of vehicles.

Bridges on the State-aid System

Bridges on the State-aid Highways do not generally carry as high volumes of traffic as do State Highways, nor are they subjected to as great a frequency of heavy loads.

These bridges, however, should have the same vertical clearance as other bridges, since vehicles are permitted to operate with loads extending 12.0 feet high. At present there are 21 bridges with an overhead clearance of less than 12.0 feet on the State-aid System. (See Table 11, page 37.)

Since most of the traffic volumes are considerably less on these State-aid Highways, the chances of meeting another vehicle on a bridge are not as great as on State Highway bridges. Consequently, it is not a great inconvenience to wait for an excessively wide vehicle on infrequent occasions. On low volume roads, widths of 14 and 16 feet will suffice for several years, but on roads carrying 200 vehicles or more per day, a 20-foot clear roadway should be provided, as the chances of meeting other and larger vehicles are greater at this traffic volume.



NARROW CULVERT

The clear roadway of a bridge or culvert should be at least 4 feet wider than the surface of the highway leading up to it.

Many of these bridges have been in use for 40 to 60 years and are not designed to withstand the loads of present traffic. Bridges constructed at the present time are designed for H-15 lane loading, the same as on State Highways. Information is lacking on the actual load carrying capacity of most of the older bridges, and it is generally impossible to determine this because the extent of damage by rust and decay is not readily measurable. However, 18 bridges were classified in 1937 as being in a generally poor condition. (See Table 11, page 37.) This is exclusive of bridges constructed during the last three years which are of adequate standards. For the bridges of less than 20-foot span there are no data available at the present time. The present statutes and financial outlays are believed adequate for the replacement of deficient State-aid bridges.

As information was available for bridges on the State-aid Connecting Links a more detailed study was made. These are used by traffic on State Highways and should be of the same standards.

TABLE 11.

BRIDGES OF 20-FOOT SPAN OR MORE ON THE RURAL STATE-AID SYSTEM CLASSIFIED BY HORIZONTAL AND VERTICAL CLEARANCES

Condition	Type	Predominating Material	Horizontal Clearance in Feet														Total	Vertical Clearance in Feet					Total
			10-13.9	14	15	16	17	18	19	20	21	22	23	24	25	28		Under 10	10-11.9	12.0-12.9	13.0-13.9	14 & over	
Good	Truss	Steel	7	12	3	11	2	3	2	11	0	0	0	1	0	0	52	0	1	0	0	51	52
		Wood	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Girder Beam or Stringer	Steel	8	10	3	7	1	14	4	54	9	29	0	8	0	0	147	0	1	0	0	146	147
		Wood	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	T-Beam	Concrete	1	1	2	4	4	20	0	71	22	18	0	0	0	1	144	0	0	0	0	144	144
	Slab	Concrete	0	1	0	0	1	6	0	13	2	2	1	3	0	0	29	0	0	0	0	29	29
	Arch	Stone	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	2	2
		Concrete	0	1	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	3	3
	Covered	Wood	1	0	5	3	4	2	0	0	0	0	0	0	0	0	15	0	4	3	6	2	15
	Sub-total		18	25	13	25	12	47	6	149	33	50	1	12	0	1	392	0	6	3	6	377	392
Fair	Truss	Steel	12	7	3	6	2	4	0	0	0	0	0	0	0	0	36	0	0	0	1	35	36
		Wood	5	6	1	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	12	12
	Girder Beam or Stringer	Steel	15	12	8	5	5	3	3	1	1	2	0	0	0	0	55	0	0	0	0	55	55
		Wood	3	1	1	0	0	0	0	0	0	0	0	1	0	0	6	0	0	1	1	4	6
	T-Beam	Concrete	1	0	0	3	0	1	0	5	2	1	1	0	1	0	15	0	0	0	0	15	15
	Slab	Concrete	0	1	0	0	1	2	0	0	0	0	0	0	0	0	4	0	0	0	0	4	4
	Arch	Stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Covered	Wood	10	9	7	9	3	0	0	0	0	0	0	0	0	0	38	1	13	16	8	0	38
	Sub-total		46	36	20	25	11	10	3	6	3	3	1	1	1	0	166	1	13	17	10	125	166
Poor	Truss	Steel	2	2	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4	4
		Wood	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Girder Beam or Stringer	Steel	3	1	0	1	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	4	5
		Wood	1	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	3
	T-Beam	Concrete	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	2	2
	Slab	Concrete	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
	Arch	Stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Covered	Wood	1	0	0	1	0	0	1	0	0	0	0	0	0	0	3	0	0	1	1	1	3
	Sub-total		7	6	0	2	0	1	1	1	0	0	0	0	0	0	18	0	1	1	1	15	18
Grand Total			71	67	33	52	23	58	10	156	36	53	2	13	1	1	576	1	20	21	17	517	576

TABLE 12.

BRIDGES OF 20-FOOT SPAN OR MORE ON THE STATE AID CONNECTING LINKS OF THE STATE SYSTEM LISTED IN THE ORDER OF DEFICIENCY INDEX /1

County	Route	Town	Station /2	HPS No. /3	Type	Span Feet	Loading Capacity	Horizontal Clearance Feet	Vertical Clearance Feet	Year Constructed	Average 24-Hour Traffic 1937 Total Vehicles	1937 Trucks Vehicles	Estimated 1945 Total Vehicles	Estimated 1950 Total Vehicles	Deficiency Index	Estimated Cost of Improvement
Windsor	Vt. 12	Woodstock Vil.	13 + 98	320	Truss	114	H-10	18	13	1900	1000 /4	53	1310	1450	13.2	$ 15,000
Lamoille	Vt. 108	Stowe Village	4 + 27	123	Covered Bridge	107	H-8	16	11	1880	620	-	812	899	12.6	25,000
Windsor	U.S. 5	White River Jct.	224 + 57 FA	140	Truss	379	H-10	20	14	1915	3000 /4	175	3930	4350	11.5	125,000 *
Caledonia	U.S. 2	St. Johnsbury	258 + 59 FA	124	Truss	158	H-10	21	Unlimited	1905	2500 /4	123	3275	3625	11.3	250,000
Windsor	Vt. 103	Chester Village	165 + 14 FA	355	T-Beam	23	H-8	21	Unlimited	1894	1400 /4	-	1834	2030	10.7	7,000
Rutland	U.S. 4	Fair Haven Vil.	91 + 64 FA	71	T-Beam	53	H-15	20	Unlimited	1925	2500 /4	175	3275	3625	4.3	5,000 *
Orange	U.S. 5	Wells River Vil.	517 + 13 FA	67	I-Beam	62	H-15	20	Unlimited	1929	1300 /4	147	1703	1885	2.2	5,000
Bennington	U.S. 7	Manchester	260 + 88 FA	35	Stone Arch	30	H-15	22	Unlimited	1909	2000	180	2620	2900	2.1	5,000
Franklin	Vt. 104	Swanton Village	[illegible]5 + 74	129	Truss	457	H-15	17	12	1900	500 /4	14	655	725	2.0	150,000
Windsor	Vt. 103	Chester	203 + 33 FA	124	T-Beam	98	H-15	20	Unlimited	1924	1200	148	1572	1740	2.0	10,000
Windsor	Vt. 11	Springfield Vil.	49 + 42 FA	247	Truss	133	H-15	20	Unlimited	1910	4000 /4	150	5240	5800	2.0	30,000
Windsor	Vt. 12	Bethel	88 + 39 FA	46	Slab	376	H-15	20	Unlimited	1929	1200	90	1572	1740	2.0	30,000

* Included in Proposed Ten Year Program.

1/ Bridges having a deficiency index of less than the average of 1.4 not included.

2/ Stations refer to straight line diagrams. Federal-aid indicated by FA.

3/ Number assigned by Highway Planning Survey.

4/ Traffic Estimated.

Some of each year's State-aid appropriations, supplemented by Federal-aid and State matching funds, are used on the State-aid Connecting Links. Table 12 is a listing of bridges on these Connecting Links for which an analysis similar to State Highway bridges was made. The following is a summary of Table 12:

1. There are 12 of these bridges on which conditions are such that free movement of traffic is seriously retarded.

2. One bridge has less than 12.0 feet vertical clearance and three bridges have vertical clearance of less than 14.0 feet.

3. Five bridges are inadequate in capacity and two are less than 18 feet in roadway width, yet carry over 500 vehicles per day.

These bridges are indicated by means of shaded triangles on Map 2, the greater the height of the triangle the greater the deficiency.

TABLE 13.

BRIDGES OF 20-FOOT SPAN OR MORE ON THE RURAL TOWN SYSTEM CLASSIFIED BY HORIZONTAL AND VERTICAL CLEARANCES

Condition	Type	Predominating Material	Horizontal Clearance in Feet													Total	Vertical Clearance in Feet					Total
			10-13.9	14	15	16	17	18	19	20	21	22	23	24	25		Under 10	10-11.9	12.0-12.9	13.0-13.9	14 & over	
Good	Truss	Steel	33	13	15	9	1	2	1	3	0	0	1	0	0	78	0	0	1	1	76	78
		Wood	7	4	1	0	0	0	0	0	1	0	0	0	0	13	0	0	0	0	13	13
	Girder Beam or	Steel	103	16	18	13	6	9	2	6	2	0	0	0	0	175	0	0	0	0	175	175
	Stringer	Wood	22	4	2	3	0	0	0	0	0	1	0	0	0	32	0	1	0	0	31	32
	T-Beam	Concrete	1	3	1	2	1	8	0	6	1	0	0	0	0	23	0	0	0	0	23	23
	Slab	Concrete	1	1	0	0	0	0	1	1	0	0	0	0	0	4	0	0	0	0	4	4
	Arch	Stone	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
		Concrete	1	1	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	3	3
	Covered	Wood	6	3	3	4	1	1	0	1	0	0	0	0	0	19	0	6	7	4	2	19
	Sub-total		175	45	40	31	9	21	4	17	4	1	1	0	0	348	0	7	8	5	328	348
Fair	Truss	Steel	54	17	5	4	0	4	0	1	0	0	0	0	0	85	0	1	0	0	84	85
		Wood	50	13	2	1	0	0	0	0	0	0	0	0	0	66	0	0	2	0	64	66
	Girder Beam or	Steel	144	23	13	22	4	5	2	1	1	0	0	0	1	216	0	0	0	0	216	216
	Stringer	Wood	106	16	1	2	0	1	0	2	0	0	0	0	0	128	0	3	1	0	124	128
	T-Beam	Concrete	2	0	0	0	0	3	0	0	0	0	0	0	0	5	0	0	0	0	5	5
	Slab	Concrete	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2
	Arch	Stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Concrete	2	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	3
	Covered	Wood	26	18	8	19	3	3	1	0	0	0	0	0	0	78	0	41	24	11	2	78
	Sub-total		386	87	29	49	7	16	3	4	1	0	0	0	1	583	0	45	27	11	500	583
Poor	Truss	Steel	12	0	0	1	0	0	0	0	0	0	0	0	0	13	0	0	0	0	13	13
		Wood	9	0	0	1	0	0	0	0	0	0	0	0	0	10	0	0	0	0	10	10
	Girder Beam or	Steel	26	3	2	1	0	0	0	0	0	1	0	0	0	33	0	0	0	0	33	33
	Stringer	Wood	22	1	2	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	25	25
	T-Beam	Concrete	1	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	2
	Slab	Concrete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Arch	Stone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Concrete	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
	Covered	Wood	4	2	1	0	1	0	0	0	0	0	0	0	0	8	2	6	0	0	0	8
	Sub-total		74	6	5	4	1	0	0	1	0	1	0	0	0	92	2	6	0	0	84	92
	Grand Total		635	138	74	84	17	37	7	22	5	2	1	0	1	1023	2	58	35	16	912	1023

TABLE 14.

UNDERPASSES ON THE STATE SYSTEM AND THE STATE AID CONNECTING LINKS CLASSIFIED BY ROADWAY WIDTHS, VERTICAL CLEARANCES AND TRAFFIC VOLUME GROUPS

Clear Roadway Widths in Feet	Average 24-Hour Traffic (1937)								Total
	100-199	200-299	300-399	400-499	500-999	1000-1999	2000-2999	3000-4999	
Under 16	1	-	-	1	1	-	-	-	3
16.0 - 17.9	-	-	-	-	-	-	-	-	-
18.0 - 19.9	-	-	-	-	-	1	-	-	1
20.0 - 21.9	2	1	1	2	3	2	5	-	16
22.0 - 23.9	-	1	1	-	-	1	-	1	4
24.0 & Over	-	-	-	-	3	7	1	2	13
Total	3	2	2	3	7	11	6	3	37
Clear Vertical Heights in Feet									
9.0 - 9.9	-	-	-	1	-	-	-	-	1
10.0 - 10.9	-	-	-	1	1	-	-	-	2
11.0 - 11.9	-	-	1	-	2	-	1	-	4
12.0 - 12.9	-	-	-	1	2	4	2	1	10
13.0 - 13.9	2	1	-	-	-	1	2	2	8
14.0 & Over	1	1	1	-	2	6	1	-	12
Total	3	2	2	3	7	11	6	3	37

Bridges on the Town System

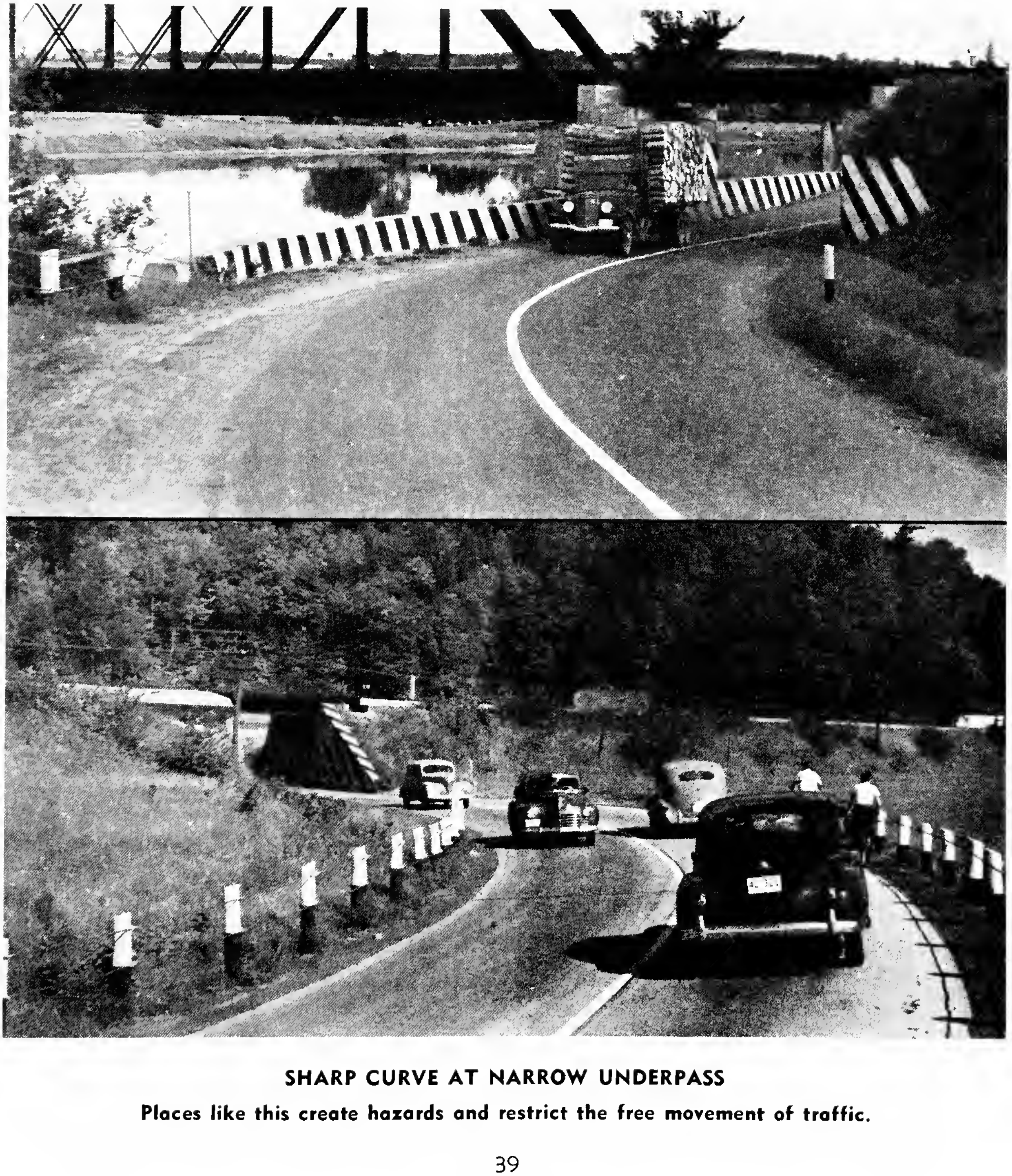
There are 1,023 bridges on the rural town system having a span length of 20 feet or over. These are shown in Table 13, classified by condition, type, and horizontal and vertical clearance. It will be noted that there are 348 bridges classified as good, 583 as fair, and 92 as poor. Of the 92 classified as poor, 35 are of the wood stringer and truss type and will probably need attention first. The remaining 57 classified as poor will serve the small volume of traffic using them for a good many years and need not be considered for replacement unless traffic increases considerably. No data are at present available on bridges of less than 20-foot span length on the Town System.

During 1939, over 40 bridges of 6-foot span and over were replaced on the Town System with P. W. A. funds, State funds, and Town funds.

Underpasses and Overpasses

Highway underpasses and overpasses present much the same problem as do bridges, being restrictive to the free movement of traffic in regard to curvature, vertical clearance, and roadway width. In fact, underpasses present a more serious problem than bridges with regard to roadway width, particularly during the winter months when snow and ice make it difficult during the bad weather to maintain the full width of the travelled way. Sharp curves and limited vertical clearance make many of these underpasses a menace to traffic and restrict the use of the highway for military operations as well as for regular traffic.

Table 14 classifies underpasses on the State System and State-aid Connecting Links according to roadway width, vertical clearance, and traffic volume. The 37



SHARP CURVE AT NARROW UNDERPASS

Places like this create hazards and restrict the free movement of traffic.

structures are summarized according to roadway width as follows:

Roadway Width	*Number*
24 ft. and over	13
Less than 24 ft.	24
Less than 22 ft.	20
Less than 20 ft.	4
Less than 18 ft.	3
Less than 16 ft.	3

It will be noted that, of the three less than 16 feet, one is carrying a traffic volume of between 500 and 1,000 vehicles per day; and that of the four less than 20 feet, one is carrying a traffic volume of between 1,000 and 2,000 vehicles per day.

Seven underpasses have a vertical clearance of less than 12.0 feet, the legal maximum height permitted for vehicles.

In addition to the roadway width and vertical clearance, the sight distance and curvature on approaches create a hazard to motor vehicles. Some underpasses have sight distances of less than 50 feet which, coupled with curves of 20 to 40 degrees, present a formidable traffic hazard.

An analysis of all underpasses on State Highway and State-aid Connecting Links has been made similar to that for bridges for the purpose of determining which underpasses are most dangerous to the free movement of traffic. In this analysis an index was computed for each structure taking into consideration roadway width, approach alignment, and traffic. These factors are listed in Table 15 for those underpasses having deficiencies greater than the average.

All seven of the underpasses with vertical clearances less than 12.0 feet are included in this listing. Only three out of the 15 listed have roadway widths of more than 20 feet. The order of priority expressed in this schedule indicates the relative need at these locations for improvement by relocation or reconstruction.

There are three overpasses on the State System and two on the State-aid Connecting Links. Of this number, four are inadequate because of capacity and three of these have roadway widths of less than 24 feet. (See Table 15, page 40.)

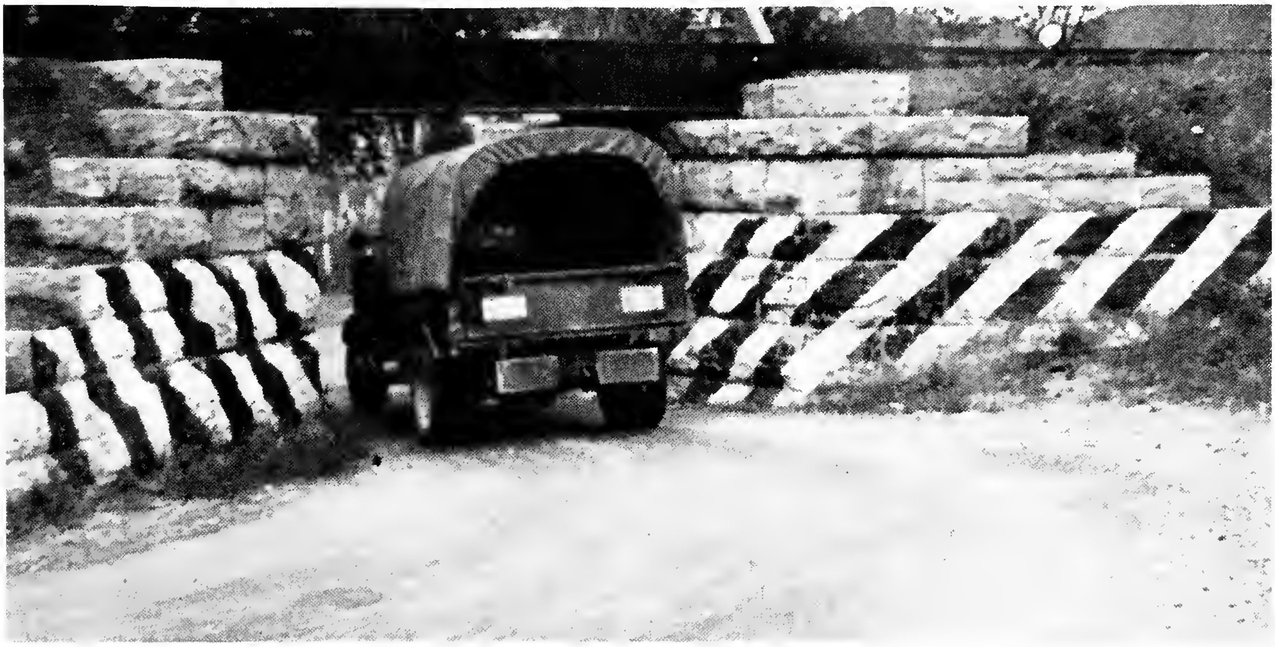
Those underpasses and overpasses having a deficiency greater than the average are shown on Maps 1 and 2. Map 1 shows the structures on the State System by means of a yellow triangle and Map 2 shows the structures on the State-aid Connecting Links by means of a shaded triangle.

TABLE 15.

UNDERPASSES AND OVERPASSES ON THE STATE SYSTEM AND THE STATE AID CONNECTING LINKS LISTED IN THE ORDER OF DEFICIENCY INDEX /1

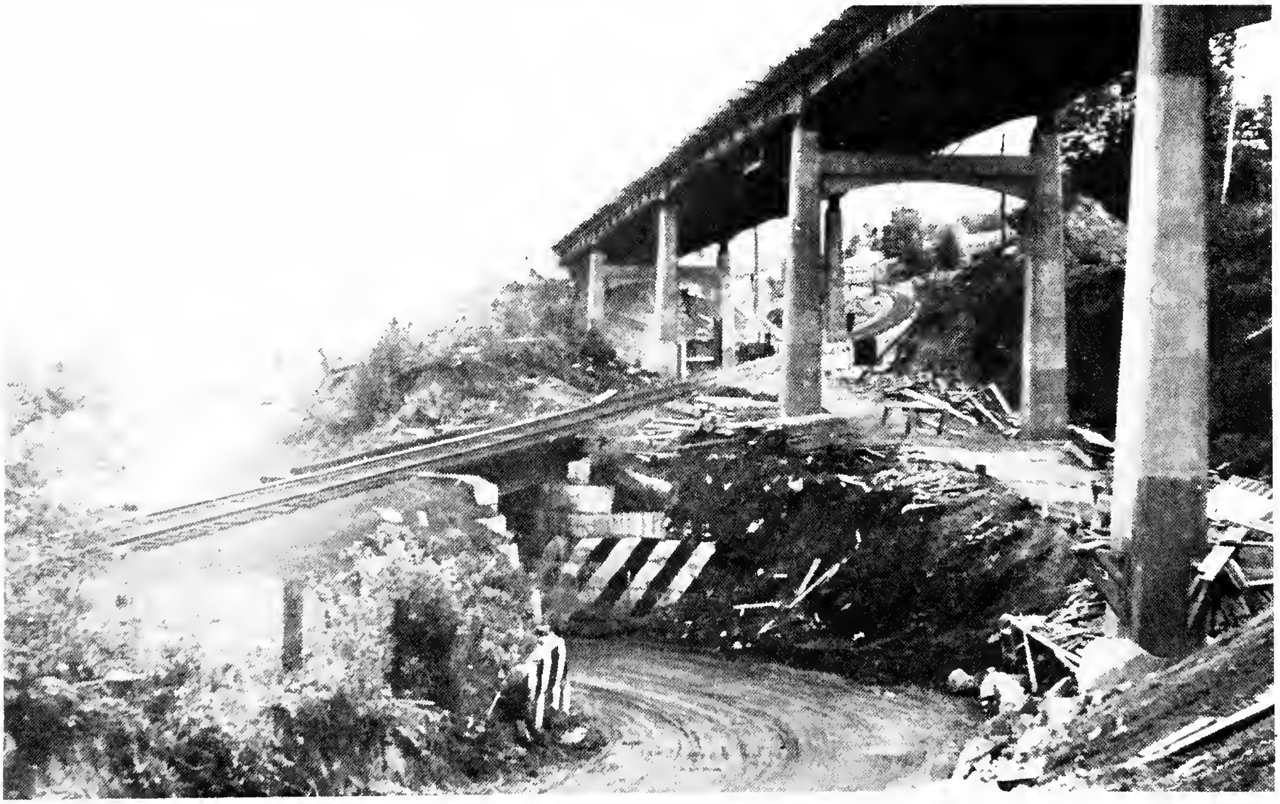
County	Route	Town	Station /2	HPS No. /3	Type	Span Feet	Loading Capacity	Horizontal Clearance Feet	Vertical Clearance Feet	Average 24-Hour Traffic				Deficiency Index	Cost of Improvement
										1937		Estimated 1945	Estimated 1950		
										Total Vehicles	Trucks Vehicles	Total Vehicles	Total Vehicles		
State System															
Underpasses															
Rutland	Vt. 30	Poultney	396 + 64	46B	I-Beam	18	-	15.0	9.6	450	32	590	650	13.4	$ 60,000
Grand Isle	U.S. 2	Alburg	332 + 66 FA	32B	I-Beam	15	-	14.0	10.0	500	60	655	725	13.3	70,000
Essex	Vt. 102	Bloomfield	14 + 43	20B	I-Beam	20	-	20.0	11.0	425	50	557	616	7.4	60,000
Lamoille	Vt. 15	Wolcott	125 + 03 FA	34B	Girder	21	-	20.0	10.5	500	90	655	725	7.4	30,000
Orleans	Vt. 105	Newport	152 + 50 FA	40B	Plate Girder	20	-	20.0	11.0	680	100	891	986	7.1	50,000
Franklin	U.S. 7	Swanton	255 + 21 FA	31B	I-Beam	19	-	18.8	13.6	1500	150	1965	2175	6.8	150,000 /5
Franklin	Vt. 104A	Georgia	91 + 02	23B	Arch	44	-	15.5	20.0	130	15	170	189	5.4	75,000
Washington	U.S. 2	Middlesex	134 + 43 FA	52B	Girder	33	-	20.0	12.0	2400	259	3144	3480	5.3	100,000
Washington	U.S. 2	E. Montpelier	261 + 26 FA	51B	Girder	32	-	20.0	12.5	1250	123	1638	1813	5.2	70,000
Windsor	Vt. 14	Royalton	271 + 53 FA	76B	Girder	26	-	20.0	12.0	1100	156	1441	1595	5.1	100,000
Caledonia	U.S. 302	Groton	164 + 98 FA	9B	Girder	22	-	21.0	11.5	340	40	445	493	4.8	25,000
Windsor	Vt. 14	Royalton	202 + 59 FA	75B	Girder	64	-	30.0	16.3	1100	156	1441	1595	4.0	50,000
Overpasses															
Windsor	Vt. 10A	Norwich	6 + 23	45A	Wooden Beam	30	H-10	20.0	-	600	90	1048	1160	12.3	60,000
Essex	Vt. 102	Maidstone	134 + 79	16A	Wooden Beam	112	H-10	20.0	-	100	15	131	145	10.3	40,000
Windsor	Vt. 103	Chester	453 + 27 FA	41A	I-Beam	325	H-15	19.8	-	1150	164	1507	1668	4.2	125,000
State Aid Connecting Links															
Underpasses															
Washington	U.S. 2	Waterbury Vil.	56 + 84 FA	61B	Girder	36	-	20.0	11.3	2500	300	3275	3625	19.5	250,000
Addison	U.S. 7	Vergennes	84 + 98 FA	3B	Girder	20	-	20.0	14.0	2000	225	2620	2900	4.4	65,000
Windsor	U.S. 5	White River Jct	220 + 09 FA	73B	Girder	40	-	20.8	12.0	3000	175	3930	4350	4.8	100,000
Overpasses															
Chittenden	U.S. 7	Winooski City	11 + 26 FA	14A	Stringer	25	H-10	38.0	-	3000 /4	225	3930	4350	11.5	14,000
Essex	Vt. 105	Island Pond	256 + 73 FA	48A	Wood Beam & Truss	562	H-8	24.0	-	300 /4	-	393	435	11.1	200,000

1/ Underpasses having a deficiency index of less than the average of 3.8 not included.
2/ Stations refer to straight line diagrams.
3/ Number assigned by Highway Planning Survey.
4/ Traffic estimated.
5/ Cost of Improvement includes bridge and underpass.



NARROW UNDERPASS WITH LOW CLEARANCE

Sharp curves and limited vertical clearance make many of these underpasses a menace to traffic.



SHARP CURVES AND NARROW ROADWAY

The elimination of a dangerous underpass (construction in progress).

RAILROAD CROSSINGS

Railroads made their appearance in Vermont about 1850 and quickly replaced other forms of transportation, particularly for all long distance movement of freight and passengers. Where these railroads crossed the highways, it was necessary to change the highway to fit by construction of grade crossings, overpasses and underpasses, which at the time were not particularly hazardous for the highway traffic using them.

The change in type and volume of highway traffic with the advent of motor vehicles, however, has made railroad crossings a major hazard. What was of small importance 75 years ago has now developed into a major restriction to the free and safe movement of motor vehicle traffic.

Under the present law, Chapter 256 of the Public Laws, the Public Service Commission is authorized to order the improvement and alteration of grade crossings, when in its opinion the public safety requires such improvements and alteration. In the event of a petition from the selectmen, or from any railroad representative, the cost of such work shall be apportioned between the State, the Town in which the improvements or alterations are made and the railroad, such cost not to exceed 40 percent to the State, 10 percent to the Town and the remainder to be paid by the railroad. When the Public Service Commission authorizes such improvements and alterations upon its own intiative and in the absence of any petition, 20 percent of the expenses shall be paid by the State and the remainder shall be paid by the railroad.

In 1917, a law was enacted requiring each railroad to spend, for each mile of track in operation, not less than 75 dollars for the removal of grade crossings. However, the Public Service Commission may, after notice and hearing, exempt any railroad from the above requirement. The railroads complied with this law up to and including the year 1931 and have been exempt for the last nine years.

The elimination or protection of hazardous grade crossings which prevent the smooth flow of large volumes of traffic with safety should continue as rapidly as available funds will permit. Federal funds have been provided for this purpose in several recent Acts and are an outright grant. The State is required to pay for the right of way and preliminary engineering costs. **Although total elimination is not always practical or economically possible, all dangerous crossings should at least have adequate protective devices installed.**

The inventory of railroad crossings on all roads and streets in the State shows that there are 697 crossings at grade, 502 of which are considered rural. The 60 highway overpasses and 107 underpasses were discussed in detail under Highway Structures.

Grade Crossings on the State System

There are 77 crossings at grade on the State System. These are protected as follows:

Type of Protection	*Number of Crossings*
Automatic Barrier	1
Automatic Gates	2
Watchman (part time)	2
Lights	23
Signs Only	49
All Types	77

Much study has been given to the subject of hazards and delays at grade crossings, and numerous attempts have been made to devise a formula which will permit the rating of each crossing in the order of relative importance of elimination or protection. The Public Roads Administration has for some time been studying data concerning grade crossings with accident records collected in the planning surveys in numerous States, with the hope of developing a better formula for hazard rating than any now in use. This study has not yet been carried through to conclusion.

In the absence of a single, generally accepted formula, a study was made of several methods of hazard rating in use in other States. From these an index was devised which is in accordance with the best informed opinion concerning grade crossing hazards.

This index or deficiency rating was based on both highway and railroad traffic. Other conditions such as sight distance, gradient, train speed, frequency of night trains, number of times the crossing is blocked, and the type of protection also were used. The actual number of accidents at each crossing was not taken into consideration because the accident experience in Vermont alone is not sufficiently broad to permit the elimination of erratic results caused by chance accidents or accidents which were the fault of the driver and had no relation to the hazard of the crossing itself.

The average index determined for grade crossings on the State System was 2.6, and there were found to be **21 crossings which have conditions more hazardous than this average. These are the ones which should be considered in any future program of elimination or improvement in type of protection.** (See Table 16.)

Grade Crossings on State-aid System

On State-aid Highways there are 188 grade crossings of which 32 are on the State-aid Connecting Links. These crossings have the following types of protection:

TABLE 16.

RAILROAD GRADE CROSSINGS ON THE STATE SYSTEM LISTED IN THE ORDER OF DEFICIENCY INDEX /1

County	Town	Route	HPS No. /2	Shortest Clear View /3	Name of Railroad	Type of Protection	Average 24-Hour Traffic				Deficiency Index	Estimated Cost of Elimination	Estimated Cost of Protective Devices
							1937		Estimated				
							Total	Trucks	1945	1950			
							Vehicles	Vehicles	Vehicles	Vehicles			
Caledonia	Lyndon	U.S. 5	643 FA	50 - 149	Canadian Pacific	Lights	1500	200	1965	2175	17.4	$100,000	-
Washington	Berlin	Vt. 12	362 FA	50 - 149	Central Vermont	Automatic Gate	1325	160	1736	1921	17.2	125,000	-
Rutland	Shrewsbury	Vt.103	168 FA	150 - 249	Rutland	Signs Only	1175	145	1539	1704	11.8	60,000	$3,000
Windsor	Cavendish	Vt.103	153 FA	0 - 49	Rutland	Lights Flashing	1230	164	1611	1784	10.4	200,000	-
Grand Isle	Alburg	U.S. 2	127 FA	0 - 49	Rutland & C. V.	Watchman 14 hours	550	60	721	798	9.6	260,000	-
Rutland	Shrewsbury	Vt.103	169 FA	250 - 349	Rutland	Signs Only	1175	145	1539	1704	9.2	60,000	3,000
Orange	Fairlee	Vt.25A	14	0 - 49	Boston & Maine	Lights	500	60	655	725	8.4	75,000	-
Caledonia	Burke	U.S. 5	636 FA	150 - 249	Canadian Pacific	Lights Flashing	870	98	1140	1262	7.8	100,000	-
Caledonia	Lyndon	Vt. 114	639	0 - 49	Canadian Pacific	Lights Flashing	550	98	721	798	7.0	200,000	-
Addison	New Haven	U.S. 7	95 FA	450 - 749	Rutland	Automatic Gate	1600	283	2096	2320	5.8	150,000	-
Caledonia	Danville	U.S. 2	678 FA	50 - 149	St. J. & L. C.	Signs Only	1100	160	1441	1595	4.8	70,000	3,000
Caledonia	Danville	U.S. 2	681 FA	50 - 149	St. J. & L. C.	Signs Only	1100	160	1441	1595	4.8	170,000	3,000
Rutland	Rutland	U.S. 4	289 FA	0 - 49	Clarendon-Pittsford	Signs Only	3100	375	4061	4495	4.0	85,000	3,000
Caledonia	Danville	U.S. 2	682 FA	50 - 149	St. J. & L. C.	Signs Only	760	89	996	1102	3.6	125,000	3,000
Rutland	Fair Haven	U.S. 4	236 FA	50 - 149	Delaware & Hudson	Lights Flashing	1550	175	2031	2248	3.5	100,000	-
Bennington	Manchester	Vt. 11	56 FA	50 - 149	Rutland	Lights Flashing	450	54	590	653	3.2	120,000	-
Caledonia	Hardwick	Vt. 15	709 FA	0 - 49	St. J. & L. C.	Signs Only	730	80	956	1059	3.2	90,000	3,000
Rutland	W.Rutland	U.S. 4	265 FA	150 - 249	Delaware & Hudson	Lights Flashing	3100	375	4061	4495	3.2	80,000	-
Caledonia	Hardwick	Vt. 12	701	0 - 49	St. J. & L. C.	Signs Only	340	41	445	493	3.0	100,000	3,000
Bennington	Pownal	Vt. 346	27	450 - 749	Boston & Maine	Lights Flashing	650	78	852	943	2.8	70,000	-
Lamoille	Wolcott	Vt. 15	714 FA	50 - 149	St. J. & L. C.	Signs Only	475	57	622	689	2.8	50,000	3,000

1/ Crossings having a deficiency index of less than the average of 2.6 not included.
2/ Number assigned by Highway Planning Survey. Federal-aid indicated by FA.
3/ Shortest clear view along railroad from a point on the highway 300 feet from crossing.

TABLE 17.

RAILROAD GRADE CROSSINGS ON THE STATE AID CONNECTING LINKS OF THE STATE SYSTEM LISTED IN THE ORDER OF DEFICIENCY INDEX /1

County	Town	Route	HPS No. /2	Shortest Clear View /3	Name of Railroad	Type of Protection	Average 24-Hour Traffic				Deficiency Index	Estimated Cost of Elimination	Estimated Cost of Protective Devices
							1937		Estimated				
							Total	Trucks	1945 Total	1950 Total			
							Vehicles	Vehicles	Vehicles	Vehicles			
Caledonia	St.Johnsbury	U.S. 2	651	50 - 149	Canadian Pacific	Automatic Gate	3080	462	4035	4466	24.0	$200,000	-
Rutland	Rutland	U.S. 7	174	50 - 149	Rutland	Watchman (7 AM - 11 PM)	5000	750	6550	7250	20.2	225,000	$5,000
Bennington	Bennington	Vt. 9	183	0 - 49	Rutland	Signs	1970	295	2581	2857	20.1	150,000	-
Chittenden	Essex Jct.	Vt. 15	379	50 - 149	Central Vermont	Lights Flashing (1940)	1700	255	2227	2465	18.5	250,000	*
Bennington	Bennington	U.S. 7	188	50 - 149	Rutland	Lights Flashing	3560	534	4664	5162	16.2	175,000	-
Caledonia	St.Johnsbury	U.S. 5	648	0 - 49	Canadian Pacific	Wigwag and Bells	1625	244	2129	2356	15.1	200,000	-
Caledonia	Lyndonville	U.S. 5	642	0 - 49	Canadian Pacific	Lights Flashing	1675	251	2194	2429	11.8	150,000	-
Orange	Randolph	Vt. 12	338	50 - 149	Central Vermont	Automatic Gate	1610	242	2109	2335	10.2	200,000	-
Bennington	N.Bennington	Vt. 67	38	50 - 149	Rutland	Signs Only	600	90	786	870	6.7	175,000	4,000
Windsor	Chester	Vt.103	143	50 - 149	Rutland	Lights Flashing (1940)	1200	180	1572	1740	5.7	125,000	*
Bennington	Bennington	Vt. 9	185	0 - 49	Rutland	Gates & Lights Fl.(1940)	2960	444	3878	4292	4.5	175,000	*
Lamoille	Morrisville	Vt. 15	720	50 - 149	St. J. & L. C.	Signs Only	1720	26	2253	2494	4.4	200,000	3,000
Rutland	Fair Haven	Vt.286	239	0 - 49	Delaware & Hudson	Bells	650	10	852	943	3.3	100,000	15,000
Orleans	Newport	U.S. 5	619	0 - 49	Canadian Pacific	Watchman	4075	61	5338	5909	3.2	300,000	10,000
Chittenden	Winooski	Vt. 15	453	0 - 49	Central Vermont	Lights Flashing (1940)	2500	38	3275	3625	3.1	150,000	*
Washington	Montpelier	U.S. 2	425	0 - 49	Central Vermont	Signs Only	3700	56	4847	5365	2.9	300,000	-
Washington	Barre	Vt. 14	605	0 - 49	Montpelier & W. R.	Signs Only	4050	61	5306	5873	2.4	-	3,000
Franklin	St. Albans	U.S. 7	488	0 - 49	Central Vermont	Lights Flashing (1940)	2080	31	2725	3016	1.3	125,000	*
Franklin	Swanton	U.S. 7	772	0 - 49	St. J. & L. C.	Signs Only	2000	30	2620	2900	1.2	125,000	2,800
Franklin	Enosburg Falls	Vt.105	505	50 - 149	Central Vermont	Signs Only	1155	17	1513	1675	0.8	-	3,000
Caledonia	St.Johnsbury	U.S. 2	792	50 - 149	Maine Central	Lights Flashing	1350	20	1769	1958	0.7	130,000	-
Washington	Montpelier	U.S. 2	573	0 - 49	Montpelier & W. R.	Signs Only	3700	56	4847	5365	0.4	-	3,000
Orange	Newbury	Vt. 25	18	Unlimited	Boston & Maine	Signs Only	200	3	262	290	0.35	-	3,000
Franklin	Richford	Vt.105	522	0 - 49	Central Vermont	Signs Only	270	4	354	392	0.3	100,000	3,000
Chittenden	Essex Jct.	Vt.116	456	50 - 149	Central Vermont	Gate & Fl.Sig.(1940)	865	13	1133	1254	0.2	175,000	*

1/ The average deficiency index of the crossings on the State-aid Connecting Links is 5.9.
2/ Number assigned by Highway Planning Survey.
3/ Shortest clear view along railroad from a point on the highway 300 feet from crossing.
* On 1940 program of construction.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

Type of Protection	*Number of Crossings*
Automatic Gates	3
Watchman	6
Wigwag, Lights and Bells	4
Lights	14
Bells	6
Signs	155
Total All Types	188

The 32 grade crossings on the State-aid Connecting Links, although nominally under town or other local administration, are fully as important as those on State Highways because they are located on through routes in incorporated areas. An analysis was made of these crossings similar to that for crossings on State Highways. In this analysis, seven of the 32 crossings were omitted because they were located on spur tracks operated infrequently and at which trains stop before crossing. **The average deficiency index of the crossings on the State-aid Connecting Links is 5.9. There are nine crossings which have conditions more hazardous than the average and all but two of these have a higher type of protection than signs. These two crossings should have protective devices installed as soon as available funds will permit.** (See Table 17.)

The construction of overpasses or underpasses to improve conditions on State-aid Connecting Links is not economically feasible at all locations. However, it may be possible in the near future to reduce the hazard at some grade crossings by the development of alternate routes in or near urban areas.

Grade Crossings on the Town System

On the Town System there are 432 crossings at grade; these are protected as follows:

Type of Protection	*Number of Crossings*
Watchman	11
Wigwag, Lights and Bells	6
Lights	14
Bells	6
Signs	395
Total All Types	432

On most of the Town Highway grade crossings the traffic is so light that elimination is not economically justified. However, improvement in type of protection might be made in numerous cases.

THE STATE-AID SYSTEM

The State-aid, or Selected, System of Highways was created in 1906 for the purpose of securing a connected system of highways in the State.

The State-aid System as it now exists is considered as the secondary or feeder road system for the State Highways. It is defined as consisting of highways controlled by the towns which have been selected as trunk lines from town to town and from population centers to railroad stations where there is no State Highway serving the same purpose. They are eligible to receive, under State supervision, State-aid funds for construction and maintenance.

At the present time this system consists of 2,730.7 miles of highways.

Improvements during the last three years are summarized by showing the mileage status as of January 1 of each year.

Type of Surface	*Mileage as of January 1* *1938*	 *1939*	 *1940*
High Type	116.5	134.6	140.0
Intermediate Type	218.5	245.8	266.2
Total Hard Surface	335.0	380.4	406.2
Gravel Surface	2,130.0	2,184.9	2,192.3
Unsurfaced	247.6	149.7	132.2
Grand Total	2,712.6	2,715.0	2,730.7

Over a period of two years there was an increase of 71.2 miles of hard surface roads and an increase of 62.3 miles of gravel roads. The total mileage of the system shows an increase of 18.1 miles for the two-year period.

Rural State-aid System

There are 2,511.5 miles of State-aid Highway classified as rural. (See Table 18.) This mileage is summarized as follows:

132.0 miles, or 5.2 percent, are unsurfaced;
2,156.6 miles, or 85.9 percent, are surfaced with gravel; and,
222.9 miles, or 8.9 percent, have surfaces superior to gravel.

These roads play an important part in serving the traffic of rural areas. The mileage on this system constitutes 18.6 percent of the total rural mileage, and serves 15.4 percent of the rural traffic. The volume of traffic in 1937 ranged from one vehicle per day on one road section to 1,700 vehicles per day on another.

Traffic Summary of the Rural State-aid System

22.4 miles carry over 500 vehicles per day
87.8 miles carry 300-499 vehicles per day
2,032.1 miles carry 25-299 vehicles per day
292.3 miles carry 10-24 vehicles per day
76.9 miles carry 0-9 vehicles per day

2,511.5 miles

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

It is significant that there are 76.9 miles carrying less than 10 vehicles per day and that 369.2 miles, or almost 15 percent of the rural State-aid System, are carrying a traffic volume of less than 25 vehicles per day. **It appears that some of the State-aid mileage is not serving the public in a manner commensurate with the purpose of State-aid Highways and should be removed from the system. Roads carrying less than 25 vehicles per day do not belong on this system unless they serve as important connections between other more heavily travelled State or State-aid Highways.**

Improvements

In order for the State-aid System to serve the public properly as connecting roads from town to town, it should have a gravel or better surface type. There are now 132.0[1] miles in this system that are not surfaced with anything but the natural earth.

According to tentative standards established by the Highway Department, highways carrying 300 vehicles or more per day should have a surface superior to gravel. At present, there are 23.3[1] miles of gravel surface on the State-aid System carrying 300 or more vehicles per day. Traffic forecasts indicate that most of the highways now carrying between 200 and 300 vehicles per day will be carrying 300 and over by 1950. In this category there are 97.7[1] miles of State-aid gravel roads.

The locations of gravel State-aid Roads now carrying over 300 vehicles per day and those carrying 200-299 vehicles per day are shown by means of shading on Map 3 in the Appendix. These should be hard surfaced by 1950. Also on this map are shown those State-aid Highways which at present are unsurfaced. (Composed of natural earth.)

In addition to the State-aid Highways mentioned above, the rural State-aid Connecting Links also require certain improvements. It is estimated that 2.1 miles of highway should be widened to more than two-lanes, 2.5 miles of paved highways should be reconstructed, and 0.8 miles of surface-treated gravel should be replaced by a higher type of surface.

Urban State-aid System

There are 219.1 miles of State-aid Highways and streets that are classified as urban. (See Table 3, page 13.) Of this mileage 95.2 miles are considered State-aid Connecting Links of the State System. At the present time State funds are available for the improvement of this urban mileage on the same basis as rural roads. Federal-aid is also available on such State-aid Connecting Links as are on the Federal-aid System. The continued

TABLE 18.

MILEAGE OF THE RURAL STATE-AID SYSTEM CLASSIFIED BY SURFACE TYPES AND BY TRAFFIC VOLUME GROUPS

(1937) Average 24-Hour Traffic	Surface Types						Total
	Unsurfaced	Plain Gravel	Surface Treated Gravel	Gravel Mixed-in-Place	Macadam	Concrete	
Vehicles	Miles	Miles	Miles	Miles	Miles	Miles	Miles
0 - 9	30.4	46.5	-	-	-	-	76.9
10 - 24	53.3	237.5	1.5	-	-	-	292.3
25 - 49	34.8	611.7	5.9	-	-	-	652.4
50 - 99	9.1	727.9	24.6	3.8	0.9	-	766.3
100 - 199	4.4	412.0	38.7	4.3	0.6	-	458.1
200 - 299	-	97.7	35.0	10.1	18.2	-	155.3
300 - 399	-	18.8	20.7	10.4	1.1	0.1	54.0
400 - 499	-	3.6	12.4	11.0	1.2	0.1	33.8
500 - 599	-	0.8	3.1	-	1.5	-	4.6
600 - 699	-	-	-	0.8	3.2	-	4.0
700 - 799	-	0.1 /1	-	-	-	-	0.1
800 - 899	-	-	5.4 /3	1.2 /2	-	-	6.6
900 - 999	-	-	0.5 /1	0.5 /1	-	-	1.0
1000 - 1249	-	-	-	0.4 /1	0.6 /1	0.1 /1	1.1
1250 - 1499	-	-	-	0.5 /1	-	0.4 /1	0.9
1500 - 1999	-	-	-	-	-	1.8	1.8
2000 - 2999	-	-	-	-	-	2.3 /1	2.3
3000 & Over	-	-	-	-	-	-	-
Total	132.0	2156.6	147.8	43.0	27.3	4.8	2511.5

1/ State-aid Connecting Link.
2/ 0.2 miles State-aid Connecting Link.
3/ 0.3 miles State-aid Connecting Link.

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[1] Some of this mileage is in the 1940 program.

improvement of this urban mileage should form a part of the future highway program.

On the State-aid Connecting Links it is estimated that during the next ten years 7.8 miles of surface-treated gravel should be replaced by a higher surface type; 5.8 miles of paved highways should be replaced, 32.5 miles of highways should be widened, and 6.4 miles of highways should have additional lanes. The locations of these sections are shown by means of shading on Map 2 in the Appendix.

THE RURAL TOWN SYSTEM

In addition to the State System, the State-aid System, and a few roads in forest reservations, there is a considerable mileage of local roads which are designated as the Town System. The construction and maintenance of these roads is the responsibility of the individual towns. As of January 1, 1940, there were 9,193.8 miles of rural town highways. This mileage is classified according to different surface types and is summarized as follows:

6,069.6 miles, or 66.0 percent, are unsurfaced, or composed of natural earth;
3,124.2 miles, or 34.0 percent, have been surfaced with gravel or better type.

The total traffic on these rural town highways is small in comparison with that on other roads in the State. Although these 9,193.8 miles constitute 68.1 percent of all rural road mileage, they carry only 7.8 percent of the total rural traffic in the State.

Traffic Summary on Rural Town System

0.2 mile	carry over 300 vehicles per day
71.1 miles	carry 100-299 vehicles per day
3,992.7 miles	carry 10-99 vehicles per day
5,129.8 miles	carry less than 10 vehicles per day
9,193.8 miles	

Approximately 34 percent of the rural town mileage has been surfaced at least with gravel; and, of the remaining 66 percent, 4,394.5 miles of the unsurfaced roads, or 47.8 percent of all town roads, carry less than 10 vehicles per day.

Thus it is apparent that there are few major traffic problems on town roads. However, it is recognized that the State receives certain benefits, not reflected in travel benefits alone, from the improvement of these roads. They serve the population residing along them as they have since this country was settled, and are fundamentally land service roads at the present time, even as when the farmer hauled his produce to market with a team. Their development is still for the most part the responsibility of local governmental units. It has been necessary to modify the design of their drainage structures and surfaces somewhat to accommodate safely the increased loads and speeds which the motor vehicle introduced. The use of motor vehicles has also increased maintenance costs on these roads. **These increased loads, speeds, and maintenance costs, however, are a part of increased service to the resident population and to the property adjacent to these roads.**

Certain of these local roads are in the nature of lateral, or feeder roads, which connect small communities or groups of dwellings with State-aid Highways and State

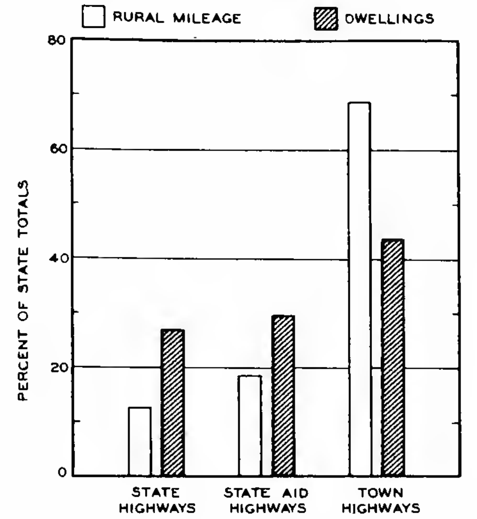
TABLE 19.

MILEAGE OF THE RURAL TOWN SYSTEM CLASSIFIED BY SURFACE TYPE AND BY TRAFFIC VOLUME GROUPS

Average 24-hour Traffic (1937)	Surface Type							Total
	Unsurfaced	Plain Gravel	Surface Treated Gravel	Bituminous Mix	Macadam Penetration	Macadam Mixed-in-Place	Concrete	
0 - 9	4394.5	735.3	-	-	-	-	-	5129.8
10 - 24	1403.0	1303.7	1.9	-	-	-	-	2708.6
25 - 49	241.1	765.8	12.3	0.1	0.7	-	-	1020.0
50 - 99	28.7	223.0	11.5	0.2	-	0.6	0.1	264.1
100 - 199	2.3	57.6	5.4	0.7	-	0.4	-	66.4
200 - 299	-	-	4.7	-	-	-	-	4.7
300 - 399	-	-	0.2	-	-	-	-	0.2
400 & Over	-	-	-	-	-	-	-	-
Total	6069.6	3085.4	36.0	1.0	0.7	1.0	0.1	9193.8

FIGURE 8.

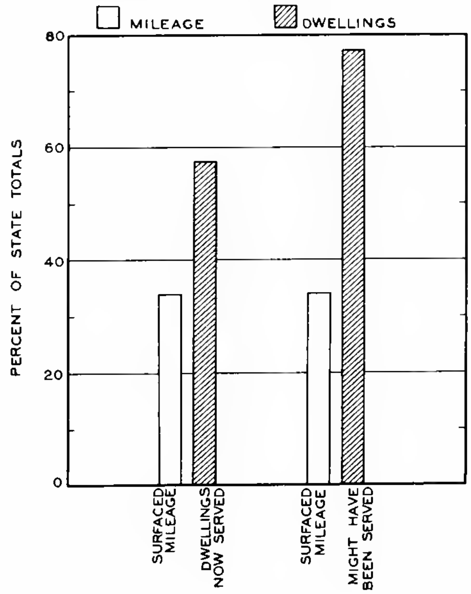
COMPARISON OF RURAL MILEAGE ON VERMONT HIGHWAY SYSTEMS WITH PERCENT OF DWELLINGS SERVED BY EACH



Highways. To assist in developing and serving those sources of travel to State Highways, the State has contributed $750,000 a year from its motor vehicle revenues for the improvement of town roads on the basis of $50.00 per mile as a direct grant to the town, and an additional $25.00 per mile if matched with town funds.

FIGURE 9.

COMPARISON OF PERCENT OF DWELLINGS NOW SERVED BY SURFACED RURAL TOWN MILEAGE WITH PERCENT WHICH MIGHT HAVE BEEN SERVED



An analysis of the expenditure of these State funds present certain inconsistencies which should be realized in any consideration of the local road problem. The dwelling density on rural town roads improved to different degrees is a measure of service rendered because it indicates how well the resident population is being served. In Table 20, page 48, there is shown the mileage of Town Roads and the number and percent of dwellings served by surfaced and by unsurfaced roads in the different dwelling density groups. Road sections used in the preparation of this table are of appreciable length, usually extending from one road intersection to another.

In the following summary, it is shown that although Town Roads constitute 68.1 percent of the total rural road mileage, only 43.4 percent of the total rural dwellings are served by them. The remaining 56.6 percent of the dwellings is served by State-aid Highways and State Highways. In Table 20, it is shown that 36.9 percent of the Town Roads do not directly serve any dwellings and are only property access roads or connecting roads between communities or other roads on the various systems.

Summary of Mileage of Rural Highways, and Dwellings Served on Each Highway System
(See Figure 8)

System	*Miles*	*Percent*	*Dwellings*	*Percent*
State Highways	1,703.0	12.6	11,661	27.0
State-aid Roads	2,511.5	18.6	12,796	29.6
Town Roads				
Surfaced	3,124.2	23.1	10,805	25.0
Unsurfaced	6,069.6	45.0	7,962	18.4
Total Town	9,193.8	68.1	18,767	43.4
Other	94.4	0.7	14	0.0
All Rural	13,502.7	100.0	43,238	100.0

During the past two years, considerable mileage of town highways has been improved. This is summarized according to mileage status as of January 1 of each year.

	Mileage as of January 1		
Type of Surface	*1938*	*1939*	*1940*
High	1.4	1.4	1.8
Intermediate	27.1	32.5	37.0
Low (gravel)	2,620.5	2,823.5	3,085.4
Unsurfaced (natural earth)	6,530.5	6,322.1	6,069.6
All Types	9,179.5	9,179.5	9,193.8

Approximately 208 miles were improved in 1938 and 267 miles were improved in 1939.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

Up to the present time, improvements to Town Highways have resulted in 3,124.2 miles being surfaced with gravel or better types of surface. A considerable portion of this work has been on roads where the dwelling density is lower than on many sections of unsurfaced roads. (In Table 20, the number of dwellings on surfaced and unsurfaced Town Highways is compared for the different dwelling density groups.)

The surfaced Town Roads represent 34.0 percent of all Town Roads and serve 57.5 percent of the dwellings on such roads. Unsurfaced Town Roads represent 66.0 percent of all Town Roads and serve 42.5 percent of the dwellings on such roads. Thus the average dwelling density is greater on surfaced roads than on unsurfaced roads, as it should be.

However, a considerable mileage of unsurfaced roads has a greater dwelling density than a considerable mileage of surfaced roads. A detailed study of this situation was made and it was found that the total mileage of town roads with a dwelling density greater than 2.5 houses per mile is approximately the same as the total surfaced mileage of town roads. If surfacing had been confined to this mileage, 77.0 percent of the rural dwellings on town roads would have been directly served by surfaced roads compared to the 57.5 percent now served, though the total mileage of surfaced roads would have been no greater than that actually existing. (See Figure 9.)

If surfacing had been confined strictly to the most densely populated roads (those with a dwelling density of 2.5 or more per mile), 1,433.4 miles of road now surfaced would have remained unsurfaced, and another 1,409.7 miles now unsurfaced would have been surfaced. Surfaced town roads having a dwelling density of less than 2.5 per mile constitute 15.6 percent of the total rural town mileage and serve only 9.3 percent of the dwellings on rural town roads. In contrast, unsurfaced roads having a dwelling density of 2.5 or more per mile constitute 15.3 percent of the total rural town mileage and serve 28.8 percent of the dwellings on rural town roads. (See Figure 10.)

Table 20.

Dwelling Density Groups Classified by Surfaced and Unsurfaced Town Highways

Mileage and Percent of the Surfaced and Unsurfaced Rural Town Highways Classified by Dwelling Density Groups

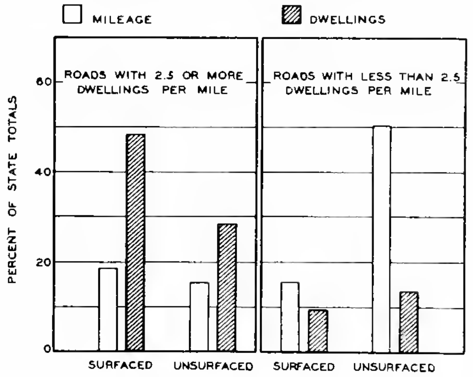
Dwelling Density Number Per Mile	Surfaced		Unsurfaced		Total	
	Miles	Percent	Miles	Percent	Miles	Percent
0.0	391.0	4.3	3,000.9	32.6	3,391.9	36.9
0.1 - 0.4	0.0	-	15.1	0.2	15.1	0.2
0.5 - 0.9	112.1	1.2	216.4	2.4	328.5	3.6
1.0 - 1.4	229.9	2.5	491.0	5.3	720.9	7.8
1.5 - 1.9	308.0	3.4	377.7	4.1	685.7	7.5
2.0 - 2.4	392.4	4.2	558.8	6.1	951.2	10.3
2.5 - 2.9	449.2	4.9	553.3	6.0	1,002.5	10.9
3.0 - 3.4	300.7	3.3	309.0	3.3	609.7	6.6
3.5 - 3.9	174.7	1.9	165.2	1.8	339.9	3.7
4.0 - 4.9	273.2	3.0	194.8	2.1	468.0	5.1
5.0 - 5.9	158.1	1.7	86.3	1.0	244.4	2.7
6.0 and Over	334.9	3.6	101.1	1.1	436.0	4.7
All Densities	3,124.2	34.0	6,069.6	66.0	9,193.8	100.0

Number and Percent of Dwellings on the Surfaced and Unsurfaced Rural Town Highways Classified by Dwelling Density Groups

Dwelling Density Number Per Mile	Surfaced		Unsurfaced		Total	
	Number	Percent	Number	Percent	Number	Percent
0.0	0	0.0	0	0.0	0	0.0
0.1 - 0.4	0	0.0	6	0.0	6	0.0
0.5 - 0.9	82	0.4	165	0.9	247	1.3
1.0 - 1.4	280	1.5	603	3.2	883	4.7
1.5 - 1.9	520	2.8	625	3.3	1,145	6.1
2.0 - 2.4	867	4.6	1,175	6.3	2,042	10.9
2.5 - 2.9	1,197	6.4	1,442	7.7	2,639	14.1
3.0 - 3.4	945	5.0	1,048	5.6	1,993	10.6
3.5 - 3.9	643	3.4	600	3.2	1,243	6.6
4.0 - 4.9	1,148	6.1	805	4.3	1,953	10.4
5.0 - 5.9	822	4.4	450	2.4	1,272	6.8
6.0 and Over	4,301	22.9	1,043	5.6	5,344	28.5
All Densities	10,805	57.5	7,962	42.5	18,767	100.0

FIGURE 10.

COMPARISON OF SURFACED AND UNSURFACED TOWN MILEAGE
WITH PERCENTS OF DWELLINGS SERVED BY EACH
FOR ROADS HAVING DWELLING DENSITIES OF 2.5 OR MORE PER MILE
AND LESS THAN 2.5 PER MILE



It is realized that there are considerations which often make it impractical to be governed solely by dwelling density in planning to surface a road. There are many miles of natural soil town roads which offer as good service as many of the surfaced roads. It is quite often necessary to surface or otherwise improve a low dwelling density section of road to connect a high density section with another surfaced road. However, the mileage affected by these conditions is relatively small in comparison with the mileage cited above.

The comparison made is on a State-wide basis and does not allow for the fact that some towns can afford to surface roads of lower dwelling densities than others. However, the study was made by towns, and inconsistencies were found within a town comparable to those found for the State as a whole. **It is obvious that the money spent on the surfacing of town roads would have resulted in serving directly a much larger proportion of the rural population if the mileage to have been surfaced had been selected in such a way as to serve the maximum number of dwellings. Since State funds are used for the development of town roads, the proper selection of roads to be improved is a matter of State-wide concern.**

State funds should be used, first, for new construction such as grading, drainage, and widening and replacing natural soil surfaces with gravel surfaces or better, and second, for the reconstruction of existing improvements. Maintenance should be paid for entirely from town funds.

ADDITIONS AND DELETIONS

An analysis of traffic on the rural State System, rural State-aid System, and rural Town System indicates that the service of a few sections of highway is not in keeping with the service which should be rendered by each system as a whole.

State Highways generally serve through traffic, State-aid roads are generally feeder roads or minor connecting links, and town roads are purely local in nature. The traffic volume generally varies in accordance with these functions, State Highways being the most heavily traveled, and town roads the least heavily travelled, though traffic volume alone is not a conclusive guide in determining on what system a given road should be. This analysis is based on a study of road mileage in relation to traffic volume, with further consideration to type of service rendered. The traffic volumes used were counted during 1937.

State and State-aid Systems

The following tabulations are presented to show the mileage of low volume State Highways and the mileage of high volume State-aid Highways.

State Highways Carrying Less Than Certain Traffic Volumes		*State-aid Highways Carrying a Certain Traffic Volume or More*	
Average Daily Traffic Volume in Vehicles	*Mileage*	*Average daily Traffic Volume in Vehicles*	*Mileage*
100	15.9	100	722.0
125	69.6	125	541.9
150	101.0	150	461.7
175	178.2	175	329.8
200	226.5	200	259.8
225	336.2	225	184.6
250	377.7	250	145.5
275	474.8	275	121.5
300	489.6	300	104.1

The mileage of State Highways carrying less than 225 vehicles per day is greater than the mileage of State-aid roads carrying more than this volume, indicating that at some traffic volume between 200 and 225 vehicles the mileage of the State Highways carrying less than that traffic volume is equal to the State-aid mileage carrying more than that traffic volume.

If it were practical to have a balanced system with no overlapping of traffic volumes, then approximately 227 miles of the State Highways carrying less than 200 vehicles per day should be removed from the State System and approximately 259 miles of the State-aid Highways carrying over 200 vehicles per day should be added to the State System. However, it would be neither economical nor practical to make such a change in all instances, as there are a considerable number of short sections of road carrying over 200 vehicles per day where the traffic is of local origin and destination. In addition to this, some of those sections do not connect with the main network of trunk line highways, nor do they perform the service of a through route. On the other hand, there are many miles of State Highways carrying less than 200 vehicles per day which form intercounty connections and which serve a large percentage of through traffic.

While it is not practicable to set traffic volume limits for establishing State Highways or State-aid Highways, this comparison does indicate those sections of State-aid Highways which are serving traffic volumes comparable to State Highways and which perhaps should be given some consideration as possible additions to the State System. It also indicates those sections of State Highways which are serving traffic volumes considerably less than volumes usually served by State Highways, and would be administered adequately as State-aid Highways.

In the preceding tabulation, 226.5 miles of State Highways are shown carrying less than 200 vehicles per day. The average daily traffic on this mileage is 140 vehicles. This average is significant only as it indicates those sections carrying the lowest volumes of traffic. Listed as follows are 100.6 miles of these State Highways carrying less than this average:

Route Number	*Location*	*Length Miles*
Vt. 30	Rawsonville to the intersection with Vt. 11 in Winhall	9.3
Vt. 102	Guildhall to Lemington	28.8
Vt. 108	Through Smuggler's Notch	10.0
Vt. 113	In the Town of Vershire	2.5
Vt. 114	Island Pond to Norton Mills	15.4
Vt. 118	Eden to Montgomery	10.8
Vt. 19	Bridport Village to Jct., Vt. 17	7.1
Vt. 104-A	**In the Town of Fairfax**	**4.7**
Vt. 2-A	**Isle La Motte Station to Toll Bridge**	**2.9**
	Brookfield State Highway	**3.1**
Vt. F-9	**Junction Route 30-A to West Cornwall**	**6.0**
	Total All Sections	100.6

A study of the individual sections shows that in some cases it is advantageous to maintain these as State Highways since they constitute through routes. In general, these are sections passing through sparsely settled areas where the volume of strictly local traffic is lower than is normally found on the State System, while the through traffic remains at the same level as on adjacent sections.

Therefore, it may be concluded that although the traffic volume is low on certain sections of the State System, in some cases their inclusion in the State System is justified for other reasons.

The last four sections listed above have more of the functions of State-aid roads and could be adequately administered as such. It is suggested that these routes be considered for deletion from the State System. Route 104-A carries 130 vehicles per day and at the present time primarily serves as a connecting link between Route U. S. 7 and Route 104. It cannot be considered as a through route. Route 2-A is serving only 110 vehicles per day and the traffic is almost entirely local. The traffic on the Brookfield route is only 75 vehicles per day and does not constitute through traffic. On Route F-9 there is no point where the average traffic is greater than 110 vehicles per day between the junction of Route 30-A and West Cornwall. The traffic between West Cornwall and Cornwall, a distance of 1.8 miles, is somewhat more but this traffic and traffic over the entire route appears to be local in naure and could be served satisfactorily by a State-aid road. It is suggested that this route be considered for deletion in its entirety.

The average daily traffic on State-aid Highways carrying 200 or more vehicles per day is 345. This is significant only as it indicates those sections which are the more important roads in this group. There are eight road sections constituting 43.9 miles of State-aid Highways carrying more than this average.

Investigations indicate, however, that most of these sections are comparatively short. They are distinctly of the auxiliary type which connect small places with larger centers of population and are not used extensively by through traffic. They are local in nature and are adequately administered as State-aid Highways.

On the basis of traffic volume and service to through traffic, however, there are three routes that could well be considered for addition to the State System. These are listed as follows:

Route Number	*Location*	*Miles*	*Average Traffic Volume (1937) Vehicles*
Vt. 67-A	Bennington to North Bennington	3.4	1,700
Vt. 3	Center Rutland to Pittsford Mills	7.9	600
Vt. 11	Chester to Springfield	8.0	400

Other sections carrying over 345 vehicles per day are all of short length and it is believed to be impractical to even consider them for incorporation into the State System. In general, the highway traffic volume on these sections is almost entirely local.

State-aid and Town Systems

The study of traffic volumes on the State-aid System and the Town System has been made in a manner similar to the analysis between the traffic on the State Highway and State-aid Highway Systems.

The following tabulation shows for various volumes of traffic the number of miles of the rural State-aid Highways having less than a certain traffic volume and the number of miles of rural Town Highways having more than a certain traffic volume.

State-aid Highways Carrying Less Than Certain Traffic Volumes		*Town Highways Carrying a Certain Traffic Volume or More*	
Average Daily Traffic Volume		*Average Daily Traffic Volume*	
Vehicles	*Miles*	*Vehicles*	*Miles*
10	58	10	4,049
25	344	25	1,348
40	740	40	740
50	998	50	332
100	1,768	100	70
200	2,230	200	5
300	2,386	300	1

In the above tabulation there are approximately 740 miles of State-aid Highway carrying less than 40 vehicles per day and about the same mileage of town roads carrying 40 vehicles per day or more.

Since it would be impracticable to consider for transfer all the State-aid Highways having traffic volumes less than 40 vehicles per day and all town roads having traffic volumes of 40 vehicles per day or more, the more important sections only were considered.

The average traffic volume on all State-aid Highways carrying less than 40 vehicles per day was found to be 20 vehicles per day. **There are approximately 130 miles of State-aid roads carrying less than 20 vehicles per day which are the least travelled State-aid Highways.** This volume is significant only as it indicates the lowest volume State-aid Highways.

The average traffic volume on town roads carrying more than 40 vehicles per day was found to be 55 vehicles per day. This volume is significant only as it indicates the most heavily travelled sections. This mileage comprises over 120 separate road sections which range in length from 0.2 miles to over 3 miles and are too numerous to list in detail in this report. **There are also approximately 130 miles of town highways carrying over 55 vehicles per day, which is the average traffic on all roads carrying over 40 vehicles per day.**

In many towns there are State-aid Highways carrying less than 20 vehicles per day and no town roads carrying 55 or more vehicles per day. In many other towns there are no State-aid Highways carrying less than 20 vehicles per day and one or more town roads carrying 55 or more vehicles per day. These volumes are significant only as they indicate the more important town roads and the least important State-aid Highways when the two classes of roads are compared. **It is evident that there have been some inconsistencies relative to traffic volumes in the selection of roads for development as State-aid Highways.**

Traffic volumes cannot be used in all cases to establish definitely the need for selecting State-aid Highways or for reducing the mileage of State-aid Highways because these highways according to law are selected as the most important roads in each town for the purpose of securing as far as possible trunk lines from town to town and as such are eligible to receive State-aid funds for construction and maintenance under State supervision. To satisfy these conditions it is sometimes necessary to give first consideration to things other than traffic volume, but extremely high volumes on town roads and extremely low volumes on State-aid Highways do indicate highway sections which should be studied to determine whether higher administrative control is warranted or whether lower administrative control would be adequate.

Based on this study the State Highway Department has prepared a map on which are shown those State-aid Highways which should be transferred to the Town System and those Town Highways which should be included in the State-aid System.

MAINTENANCE COSTS

Maintenance on highways is necessary to protect the original investment and to maintain the riding surface of the roads in such a condition that traffic will be adequately served. Factors which affect the annual cost of such maintenance include the volume of traffic using the highway, the speed of that traffic, the type of subgrade and surface of the road, the location of the road, and the availability of satisfactory local materials and labor.

Similar maintenance outlays are part of the cost of owning property for farming, industry, merchandising, and other types of business. **Maintenance costs increase with age of the road as they do with other types of property. If necessary reconstruction is postponed because of lack of funds, the resulting condition increases the necessary routine maintenance and this in turn decreases the amount of construction funds available.**

At the present time State Highway Maintenance expenditures in Vermont amount to approximately one-quarter of the total expense involved in operating the State Highways. These costs are detailed in the Biennial Reports of the Department. The principal items included under maintenance are patrol work, winter maintenance, resurfacing, surface treatment, and extra and special maintenance.

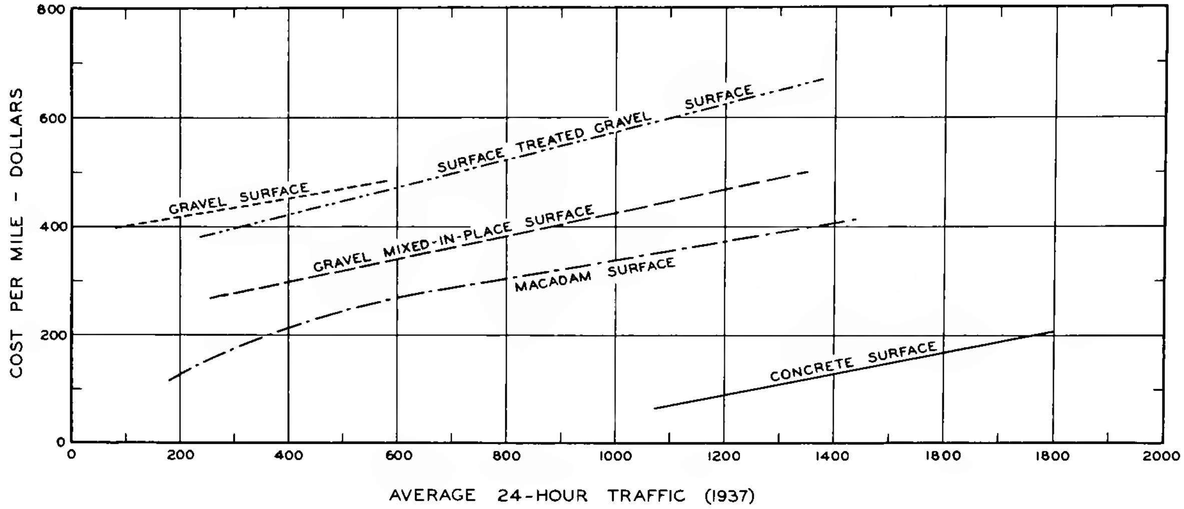
It was pointed out in the Preliminary Report of the Planning Survey that maintenance costs were increased tremendously by the transfer of 724 miles of State-aid road to the State System in 1935. This mileage required relatively higher maintenance expenditures than other parts of the State System. No additional construction appropriation was made at the time, and consequently the amount available for State Highway betterments other than maintenance was reduced.

Winter maintenance costs have increased. The public demands more and more open roads throughout the winter and as a result plowing and sanding costs have increased. These of course vary somewhat with the severity of the winter.

Other maintenance costs tend to increase as existing pavements become older and require more attention. Experience throughout the country has proved that to postpone maintenance is expensive, as the temporary reductions in expenditures are more than offset by later necessary increases in expenditures. A certain minimum amount of work must be done each year to maintain a satisfactory condition. Postponement does not reduce the average annual cost over a period of years and actually increases it slightly. In addition, postponed maintenance increases the cost to the public of operating vehicles.

FIGURE 11.

RELATION BETWEEN MAINTENANCE COST PER MILE AND AVERAGE DAILY TRAFFIC VOLUMES FOR DIFFERENT TYPES OF SURFACES



An analysis has been made of the maintenance costs of a few road sections in Vermont over the past five years, and this analysis compares the average annual maintenance costs for five predominating surface types with the average daily traffic on these types. (See Figure 11, page 52.)

It has been pointed out previously (page 28) that there were 371.5[1] miles of gravel roads carrying over 200 vehicles per day which should be improved to an intermediate type of pavement within the next ten years. Within the limits of Vermont experience, it has been indicated that the average annual maintenance cost of gravel roads carrying more than 200 to as much as 600 vehicles per day is $450 per mile. The average annual maintenance cost of a gravel mixed-in-place surface for the same traffic volume range is about $310 per mile. By the improvement of this mileage to intermediate type surfacing, it is estimated that maintenance could be reduced about $46,000 per year.

It was also pointed out that 137.1 miles of existing surface-treated gravel roads are constructed on what is now recognized to be inferior base and that high maintenance costs result from this condition. By reconstruction to at least a gravel mixed-in-place surface, it should be possible to save from $110 to $130 a mile per year in maintenance costs, depending upon the volume of traffic. It is estimated that this saving would be about $19,000 per year.

The replacement of obsolete surfaces with higher type pavements will also result in decreased maintenance costs. A change, upon retirement, from lower type to higher type surfaces would, of course, involve larger immediate construction expenditure outlays, but it would have the effect of reducing the mileages of lower type surfaces to be retired in later years. There would be progressively less of this low type surfacing in existence each year in the future and hence less annual maintenance expenditures.

It was apparent in making the analysis of maintenance costs of various surface types, according to the volume of traffic carried, that the base upon which the analysis was made is not wide enough to yield estimates throughout all ranges in traffic volumes. The limited number of sections used in the analysis are the only ones for which data on traffic and costs were readily comparable. In spite of these limitations, the trend observed in this analysis is significant and indicates the desirability of developing records so that maintenance cost classifications can be analyzed according to roadway surface types and traffic volumes for particular road sections. The development of such records would make it possible to plan a program of highway improvement, in relation to traffic volume and resulting maintenance costs, more accurately than can now be done.

In general, maintenance costs tend to increase as the traffic increases. When such costs are relatively high on any road surface, that surface should be replaced by a higher type if an appreciable savings can be effected. But changes from lower to higher type surfaces should be commensurate with such construction outlay as may be feasible with regard to the usage of the road improved.

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[1] Approximately 42 miles already programmed.

ROAD LIFE

Experience in Vermont and throughout the country has definitely proved that there is no such thing as a permanent road surface. Constant use, together with frost action, over a period of years, causes the surface to break up, crack or disintegrate. In order to determine the average service life, rate of retirement and annual cost of each type of roadway improvement, it is necessary to study records over a period of years. Such an analysis constitutes a Road Life Study.

The tabulation below shows 32.5 miles which have been retired, or replaced with the same or a different type of surface. Not all of this mileage was retired because of surface type failures. New surfaces were necessary because of relocations. Up to January 1, 1940, 44 miles of concrete had been surface treated. **The mileage necessary to be treated and resurfaced is expected to increase yearly. Until worn out concrete pavements are replaced with new pavements, maintenance costs will have a tendency to increase.**

Records compiled by the Public Roads Administration indicate that the normal improvement programs followed in most States involve considerable more retirements, in proportion to the mileage, than has been evident in Vermont. However, funds have only been available in amounts sufficient for initial construction improvements and have not as yet been sufficient to resurface and reconstruct all out-moded types consistent with changes in traffic, speed and standards.

Because of the small mileage of surfaces retired in Vermont no attempt has been made to forecast future retirements from Vermont experience. As retirements are made by reconstruction the amount of information available for analysis will increase and will more accurately portray Vermont conditions than is possible at the present time.

Mileage of Superior to Gravel State Highways Which Have Been Retired in Vermont as of January 1, 1940

Surface Type			
Replaced Type	*Replacement Type*	*Length in Miles*	
Surface Treated Gravel	Concrete	6.4	
Surface Treated Gravel	Gravel Mixed-in-Place	11.3	
Sub-total			17.7
Gravel Mixed-in-Place	Concrete	5.5	
Gravel Mixed-in-Place	Gravel Mixed-in-Place	0.4	
Sub-total			5.9
Macadam Penetration	Concrete	5.1	
Sub-total			5.1
Concrete	Surface Treated Gravel	1.3	
Concrete	Bituminous Surface on Concrete	1.1	
Concrete	Concrete	1.4	
Sub-total			3.8
Total			32.5

PART 2

HIGHWAY FINANCES

HIGHWAY REVENUES

Planning for the development and maintenance of adequate highway facilities requires not only a thorough study of the growth of highway traffic, but also the resulting revenues and receipts so that reasonable forecasts of future revenues to support necessary highway programs may be determined.

The funds available for highway purposes in Vermont come from the following sources:

1. **Town Assessments.**
2. **Federal-aid.**
3. **Registration Fees.**
4. **Motor Fuel Taxes.**

The construction of Vermont highways generally has been based on the "pay-as-you-go" principle. With but two exceptions, no construction of State Highways has been financed by borrowing:

1. Of the $8,446,736 Flood Bonds issue of 1927, $8,027,946, or 95 percent, was used for highway and bridge construction;

2. An increase in the highway debt for the fiscal year ending June 30, 1940, of $1,675,000 all of which resulted from reconstruction made necessary by the 1938 flood and hurricane.

The major portion of the Vermont highway revenues comes from registration fees and motor fuel taxes. (The details of the amounts of the funds collected from these various sources for the various years are shown in Table 21 and in Figure 12.) Previously in this report, a forecast was made of vehicle registrations, licensed motor vehicle operators, and motor fuel consumption. On the basis of these estimates, it is possible to forecast the probable future revenue if there is no diversion of motor vehicle receipts, and the present rates of taxation are maintained.

Town Assessments

Since 1931, a tax has been collected from each town based on the mileage of State Highways in that town. The funds derived from this source are small and are subject to little or no fluctuation, being based on the State Highway mileage and the grand list of each town, not to exceed $300 per mile or $5,000 per town or 20 cents on the dollar of the grand list of any one town. For the fiscal year ending June 30, 1940, the receipts from this source amounted to $223,769.

Federal-aid

Federal-aid funds first became available in 1917 and have been made available annually since that time for the construction of roads and bridges with State matching funds. Additional Federal funds are also available as a direct grant, without State matching funds, for grade crossing elimination and protection improvement and can be used on any highway system. During the period 1932-1938, when economic conditions through-

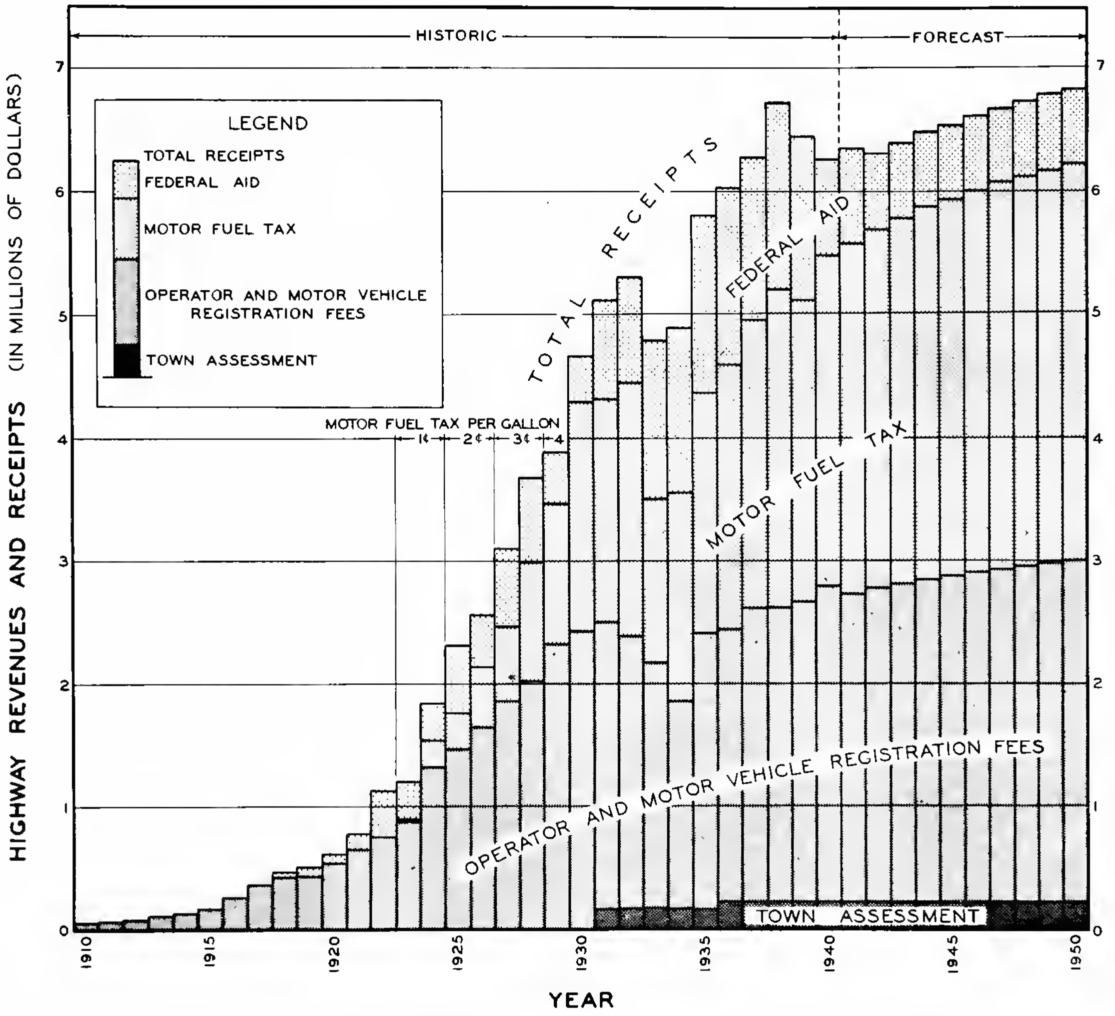
TABLE 21.
HIGHWAY REVENUES AND RECEIPTS /1 HISTORIC TO 1940, FORECAST TO 1950

Year	Registration Fees	Motor Fuel Tax	Federal Aid Receipts /2	Town Assessment	Total
Historic					
1906	$ 3,399	-	-	-	$ 3,399
1907	2,646	-	-	-	2,646
1908	4,713	-	-	-	4,713
1909	15,730	-	-	-	15,730
1910	40,984	-	-	-	40,984
1911	56,609	-	-	-	56,609
1912	75,602	-	-	-	75,602
1913	102,921	-	-	-	102,921
1914	140,088	-	-	-	140,088
1915	179,092	-	-	-	179,092
1916	266,531	-	-	-	266,531
1917	364,510	-	-	-	364,510
1918	431,463	-	$ 30,650	-	462,113
1919	436,783	-	77,588	-	514,371
1920	545,916	-	76,607	-	622,523
1921	663,989	-	129,632	-	793,621
1922	750,951	-	380,700	-	1,131,651
1923	897,074	$ 9,064	303,490	-	1,209,628
1924	1,331,457	215,878	314,895	-	1,862,230
1925	1,484,236	291,284	563,080	-	2,338,600
1926	1,658,078	507,864	411,430	-	2,577,372
1927	1,877,634	612,366	629,049	-	3,119,049
1928	2,034,334	971,983	694,118	-	3,700,435
1929	2,341,116	1,157,155	409,628	-	3,907,899
1930	2,446,635	1,874,927	366,821	-	4,688,383
1931	2,358,804	1,834,735	806,159	$152,913	5,152,611
1932	2,234,799	2,072,556	874,544	154,058	5,335,957
1933	2,018,262	1,862,852	773,503	161,796	4,816,413
1934	2,184,948	1,704,751	878,643	157,912	4,926,254
1935	2,264,610	1,970,976	1,441,956	154,562	5,832,104
1936	2,231,204	2,161,019	1,440,362	226,481	6,059,066
1937	2,413,382	2,356,089	1,322,354	222,569	6,314,394
1938	2,414,770	2,601,487	1,522,659	223,509	6,762,425
1939	2,468,527	2,565,452	1,216,420	222,612	6,473,011
1940	2,599,273	2,702,630	774,290	223,769	6,299,962
Forecast					
1941	2,532,000	2,852,000	780,000	223,000	6,387,000
1942	2,583,000	2,923,000	670,000	223,000	6,399,000
1943	2,619,000	2,984,000	670,000	223,000	6,496,000
1944	2,652,000	3,035,000	600,000	223,000	6,510,000
1945	2,681,000	3,079,000	600,000	223,000	6,583,000
1946	2,709,000	3,117,000	600,000	223,000	6,649,000
1947	2,733,000	3,150,000	600,008	223,000	6,706,000
1948	2,758,000	3,181,000	600,000	223,000	6,762,000
1949	2,781,000	3,209,000	600,000	223,000	6,813,000
1950	2,800,000	3,234,000	600,000	223,000	6,857,000

1/ Fiscal year ending June 30, compiled from Treasurer's Report.
2/ Federal-aid amounts include: from 1932 to 1936, inclusive, 1927 Flood Federal-aid; from 1932 to 1936, Emergency Federal-aid; and from 1938 on, Federal-aid Secondary and Grade Crossing Funds.

FIGURE 12

HIGHWAY REVENUES AND RECEIPTS IN VERMONT



out the country were poor, special Federal emergency appropriations in addition to regular Federal-aid were made available to the States as grants for highway construction. The amount of Federal-aid funds available annually is not fixed. The future availability of these funds depends entirely upon Congressional action. It cannot safely be presumed that they will be maintained at the level immediately preceding 1938, when large emergency appropriations were available. It is reasonable to estimate, however, what may be expected under normal economic conditions. Appropriations for 1940 and 1941 were reduced from those for 1938 and 1939, and present indications point to approximately a 14 percent reduction in 1942 and 1943 appropriations from the 1940 amounts.

Registration Fees

Income from registration fees includes that from the licensing of motor vehicles as well as the licensing of motor vehicle operators. The revenue obtained prior to 1910 was relatively small and came from motor vehicles only. Motor vehicle operators were licensed first in 1915.

A study of these figures indicates that the number of motor vehicle registrations may be expected to increase relatively slowly within the next few years. Population in Vermont showed a very slight increase in 1930 over 1920, and the 1940 census shows a slight decrease (380 persons) from the 1930 figure.

In comparing car ownership and the number of car operators in Vermont with other States and with the country as a whole, it is significant to note that Vermont's ownership of motor vehicles is slightly greater in proportion to the population than for the country as a whole. But in many States the number of vehicles in relation to the population is much greater than in Vermont, and if this trend is extended to Vermont at even a considerably reduced rate, a slight increase in registrations may be expected in car ownership. This trend may, of course, be accentuated if economic conditions improve to any appreciable extent. From the trend in motor vehicle registration and licensed motor vehicle operators (see Figure 1, page 14) it appears that the condition of proportional car ownership in Vermont is relatively stable.

The revenues from registration and license fees decreased in the four-year period 1930-1933. Since this period these revenues have increased and in 1940 slightly exceeded those received in 1930, the previous peak year.

Motor Fuel Taxes

The amount of motor fuel consumed is more directly a measure of travel and usage of roads than is registration of motor vehicles or the licensing of motor vehicle operators. Since 1923, a considerable portion of the revenue for Vermont highways has been collected in the form of a tax on motor fuel sold. This was initiated at a rate of 1c a gallon in 1923, increased to 2c a gallon in 1925, to 3c a gallon in 1927, and to 4c a gallon, the present rate, in 1929. Even with this increase in tax, there has been a distinct increase in the consumpton of motor fuel except during the period 1932-34. Consumption since these years has continued upward, though at a slightly reduced rate. (See Figure 3, page 16.)

This increased consumption is caused by the increase in the number of vehicles operated and the increase in the travel of each vehicle registered. Though some of this latter increase is undoubtedly caused by the increase in travel by out-of-State vehicles in Vermont, more Vermont-owned cars are being operated each year and the people who own them are driving more miles each year. Increased attention to winter maintenance of the highways undoubtedly has also been an important contributing factor. Based on the charted trends (see Figures 1 and 4 on pages 14 and 17 respectively), it is reasonable to expect continued increased annual travel and a corresponding increase in motor fuel consumption by motor vehicle owners although this increase may occur at a slower rate than in the past.

Highway Revenues and Receipts

Highway revenues have increased from less than **$25,000** per year in 1909, to **$514,371 in 1919, $3,907,899** in 1929, and **$6,473,011** in 1939. On the basis of this increase (see Figure 12, page 55), it may be estimated that if current tax rates remained unchanged and receipts from Federal-aid are as shown in Table 21, these several sources of revenue will produce **$6,857,000** per year by 1950.

The forecasting of the amount of revenue that may reasonably be expected from road-users in future years is important in the scheduling of the State's road program. The building of highways today must be based upon economic principles common to every sound business. If a long range program can be drawn up and followed regularly, it will be possible for the highway engineer to build highways efficiently and economically. But if the highway engineer must plan his program from year to year because of a lack of assurance of future revenue, it will be difficult to integrate a State-wide program of construction and reconstruction. The assurance of revenues must be established to permit this long range planning.

USE OF HIGHWAY REVENUES

There are four general purposes for which highway revenues have been authorized. (See Table 22, page 57.)

1. **Administration of Motor Vehicle Department.**
2. **Payment of 1927 Flood Bonds, principal and interest.**
3. **Payment of 1938 Storm Notes, principal and interest.**
4. **Highway construction and maintenance.**

From the estimate of future revenues made previously, it is possible to determine the funds which may be reasonably expected for highway use each year after allotting the funds necessary for the operation of the Motor Vehicle Department and the annual payment of principal and interest on the Flood Bonds and Storm Notes. This has been shown for the years 1940-50 inclusive. (See Table 22, page 57.)

Previous to 1931, the money for the administration of the Motor Vehicle Department was taken from the General Funds of the State. During that year it was appropriated from the Motor Vehicle receipts. At that time this amounted to $130,319. In general, the cost of administering the Motor Vehicle Department is proportional to the revenues collected. Since 1930, the

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

Motor Vehicle Department expenses have increased from $131,670 to approximately $191,000 in 1940, an increase of about 45 percent. An amount of $250,000 is estimated for the year 1950, an increase of about 30 percent. This increase is based on the proportional increase in total estimated revenue.

TABLE 22.

USE OF HIGHWAY REVENUES /1 HISTORIC TO 1940, FORECAST TO 1950

Year	Administration of Motor Vehicle Department	Principal and Interest Flood Bonds		Highways	Total /2
		1927	1938		
Historic					
1930	$131,670	$694,831	-	$3,861,882	$4,688,383
1931	130,319	728,169	-	4,294,123	5,152,611
1932	124,741	711,481	-	4,499,735	5,335,957
1933	125,367	695,769	-	3,995,277	4,816,413
1934	110,407	743,225	-	4,072,622	4,926,254
1935	110,000	656,094	-	5,066,010	5,832,104
1936	146,000	640,156	-	5,272,910	6,059,066
1937	146,000	624,219	-	5,544,175	6,314,394
1938	198,000	608,281	-	5,956,144	6,762,425
1939	178,000	692,344	-	5,602,667	6,473,011
1940	191,000	576,000	$401,000	5,131,962	6,299,962
Forecast					
1941	198,000	560,000	409,000	5,220,000	6,387,000
1942	204,000	545,000	479,000	5,171,000	6,399,000
1943	209,000	529,000	476,000	5,282,000	6,496,000
1944	214,000	513,000	474,000	5,309,000	6,510,000
1945	220,000	497,000	291,000	5,575,000	6,583,000
1946	226,000	481,000	-	5,942,000	6,649,000
1947	233,000	465,000	-	6,008,000	6,706,000
1948	239,000	449,000	-	6,074,000	6,762,000
1949	245,000	433,000	-	6,135,000	6,813,000
1950	250,000	-	-	6,607,000	6,857,000

1/ Fiscal year ending June 30.
2/ Differences in Grand Totals between Tables 22 and 23 are due to unexpended balances.

In 1945, the last payment of $291,000 will be made on the 1938 Storm Notes and will make available approximately $470,000 more for highways during 1946 than was available in 1944. Principal and interest payments on the 1927 Flood Bonds are gradually decreasing. The last payment, to be made in 1949, amounts to $433,000. **The final payments of each of these notes will release funds that are greatly needed if our highways are to be brought up to the standards required by present day traffic and the increased traffic which it is estimated will be using our highways by 1950.**

Previous to 1933, both the principal and interest payments were appropriated from the General Funds of the State. The payment of these notes and bonds and the payment of the Administration of the Motor Vehicle Department from Motor Vehicle Revenues has made available more funds for general use and at the same time it has been possible to decrease general taxation somewhat.

The transfer of supervision and engineering highway accounts from the General Funds to Motor Vehicle Receipts, amounting to $130,000 in 1927 the year transferred, and the elimination of the 5 percent tax on the Grand List amounting to approximately $150,000 are two other changes made. These changes totaling $1,081,000 between 1927 and 1935 shifted the burden of some of the highway financing from local taxation to the Motor Vehicle receipts and revenues.

The addition of 724 miles in 1935 to the State System relieved the towns of considerable expense and increased the mileage of State Highways which were below standard. **The mileage of State Highway which the State can construct and maintain at a standard which will serve modern traffic adequately is limited by the funds available. The increase in the mileage of the State Highway System and the decrease in the funds available for highway use from Motor Vehicle receipts due to the above mentioned changes has retarded the necessary development of the State System of Highways.**

VEHICLE-MILE EXPENDITURES

On the basis of 1937 traffic it is estimated that approximately 673 million vehicle-miles are travelled annually on Vermont highways. The following tabulation shows the State appropriations, vehicle-miles and cents per vehicle-mile.

System	*Appropriations (1940)*	*Vehicle-miles per year*	*Cents per vehicle-mile*
State	$2,240,000	485,345,000	46/100 cents
State-aid	850,000	93,110,000	91/100 cents
Town	750,000	95,234,000	79/100 cents
	$3,840,000[1]	673,689,000	57/100 cents

Thus it can be seen that although travel on the State System amounted to nearly 500 million vehicle-miles or approximately five times the travel on either the State-aid or Town Systems, less than one-half of a cent per vehicle-mile was appropriated for State Highways in comparison to nine-tenths of a cent for the State-aid System and approximately eight-tenths of a cent for the Town System.

If the State appropriation of $2,240,000 for State Highways is increased by $780,000 in Federal-aid the distribution is more evenly balanced. This makes a total of $3,020,000 for the State System or approximately sixty-two-hundredths of a cent per vehicle mile as compared with forty-six-hundredths of a cent in the above tabulation.

In some States highway funds have been allotted on a vehicle-mile basis. The following tabulation shows how highway funds, including Federal-aid, would be distributed among the three highway systems in Vermont on a vehicle-mile basis:

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[1] Includes only state appropriations and not those of other units of government.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

System		*Amount*	*Cents per Vehicle-mile*
State	$2,548,385		
Federal-aid	780,000		69/100 cents
Total		$3,328,385	
State-aid		638,525	69/100 cents
Town		653,090	69/100 cents
Total		$4,620,000	

Thus, the distribution of State funds according to travel would amount to nearly seven-tenths of a cent per vehicle-mile on each highway system. Distributing highway funds in this manner would mean an addition of approximately $300,000 on the State System, a reduction of about $200,000 on the State-aid System and a reduction of about $100,000 on the Town System. However, it is realized that the income from gasoline taxes resulting from heavier travel on State Highways will be used as a subsidy for State-aid and Town Highways, but sufficient funds must be allotted to maintain, reconstruct and resurface the higher volume State Highways in accordance with the traffic using them.

A study of road use shows that on State Highways rural residents contribute 52 percent of the travel and urban people 48 percent. On State-aid Highways rural people contribute 75 percent and urban people 25 percent. On city and village streets the rural people contribute 30 percent and the urban people 70 percent, and on rural Town Highways rural people contribute 86 percent and urban 14 percent. The rural dweller does approximately 60 percent of his travelling on main highways and the urban dweller performs about 56 percent of his travel on main highways.

EXPENDITURES

The total expenditures by the State for construction and maintenance on the State, State-aid and Town Systems during the past ten years amount to $53,824,271. The annual expenditures on the State System range from a low of $2,450,695 in 1934 to a high of $4,482,291 in 1938; the average for the period being $3,426,529 spent each year. (See Table 23.) The decrease in 1934 resulted from the decrease in both motor vehicle registration fees and motor fuel taxes. Increased Federal-aid receipts amounting to nearly a million and a half dollars, resulting from special emergency appropriations, accounts for the large expenditure in 1936. On the whole, however, no well defined trend either upward or downward occurred between 1930 and 1940.

The estimated total available State revenue for highway purposes from all sources for the next ten-year period, from 1941 to 1950, amounts to $57,323,000. (See Table 23.) Over the entire period this amount is divided as follows: $7,750,000 for Town Highways, $10,075,000 for State-aid Highways and $1,805,000 for supervision, engineering and office expense. This leaves a total of $37,693,000 for construction and maintenance on the State System. The estimated amount available annually for this work from 1941 to 1950 inclusive, is shown in column 11 in Table 24, page 59. This amount is subdivided into maintenance on the State System, column 10; construction on the Federal-aid System, column 6; construction on the Federal-aid Secondary System, column 7; and, construction on the Non-Federal-aid State System, column 8.

An increase in winter maintenance expenditures is estimated for the next ten years. Winter maintenance has increased from $318,664 in 1936 to $477,068 in 1940, a total of $158,404 in four years. It is anticipated that additional winter maintenance will be demanded by the travelling public in the future and $677,000 is estimated by 1950, which is an increase of approximately $20,000 a year. This makes a total of $14,600,000 for maintenance during the ten-year period.

This increase in winter maintenance will be offset to some extent by decreasing maintenance costs on low surface type highways that are improved to a higher type of surface; but, this in turn will be offset by higher maintenance costs on concrete highways where the life of the surface is gradually decreasing with the increase in age. As a result the total maintenance costs will show an increase.

The total estimated funds available for road and bridge construction on the Federal-aid System amount to $13,541,000 and for road and bridge construction on the non-Federal-aid State System and the Federal-aid Secondary System $8,561,000. A reduction in Federal-aid from previous years, reductions in payments on the principal and interest of Flood Bonds and Storm Notes, together with estimated increases in registration fees and motor fuel taxes, creates additional construction funds for non-Federal-aid State Highways. For the year 1950 these funds are estimated at $1,031,000. (See Table 24, page 59.) Federal-aid grants for grade crossings, overpasses, and underpasses are estimated at $991,000 and can be used on any system.

Expenditures by the State on State-aid Highways have remained between one and two million dollars, being slightly over two million in 1935, but averaging slightly over a million dollars from 1935 to 1939. (See Table 23, page 59.)

Expenditures by the State on Town Highways have increased from $311,202 in 1930 to $731,169 in 1939. These expenditures are fixed by legislative act to

TABLE 23.
STATE EXPENDITURES ON THE HIGHWAY SYSTEMS (INCLUDES FEDERAL AID) /1
HISTORIC TO 1940 - FORECAST TO 1950

Year	Supervision Engineering Office Expense Col. 1	State Highway System Construction and Maintenance Col. 2	State-aid System Construction and Maintenance /2 Col. 3	Town System Construction and Maintenance /2 Col. 4	Grand Total /3 Col. 5
Historic					
1930	/4	$ 3,104,389	$ 1,904,264	$ 311,202	$ 5,319,855
1931	/4	4,040,190	1,638,952	305,923	5,985,065
1932	/4	3,771,174	1,096,920	473,008	5,341,102
1933	/4	3,064,733	1,100,477	498,682	4,663,892
1934	$ 114,159	2,450,695	1,441,911	511,156	4,517,920
1935	121,107	2,676,195	2,267,848	534,639	5,599,789
1936	142,140	3,346,627	1,142,367	511,130	5,142,264
1937	135,013	3,873,269	1,055,893	492,409	5,556,584
1938	142,652	4,482,291	1,115,739	736,515	6,477,197
1939	155,492	3,627,104	1,158,811	731,169	5,672,576
1940	152,794	2,933,015	1,047,092	734,981	4,867,882
Forecast of Available Funds					
1941	158,000	3,462,000	850,000	750,000	5,220,000
1942	163,000	3,333,000	925,000	750,000	5,171,000
1943	168,000	3,414,000	950,000	750,000	5,282,000
1944	173,000	3,411,000	975,000	750,000	5,309,000
1945	178,000	3,647,000	1,000,000	750,000	5,575,000
1946	183,000	3,984,000	1,025,000	750,000	5,942,000
1947	188,000	4,020,000	1,050,000	750,000	6,008,000
1948	193,000	4,056,000	1,075,000	750,000	6,074,000
1949	198,000	4,087,000	1,100,000	750,000	6,135,000
1950	203,000	4,279,000	1,125,000	1,000,000	6,607,000
Totals 1941-1950 inclusive	$1,805,000	$37,693,000	$10,075,000	$7,750,000	$57,323,000

1/ Fiscal year ending June 30; compiled from annual State Highway Report.
2/ Does not include Town Contributions.
3/ Difference in Grand Totals between Tables 22 and 23 are due to unexpended balances. Amounts compiled from Highway Department Records.
4/ Amounts included under Construction and Maintenance.

TABLE 24.

ESTIMATED AVAILABLE REVENUE ON THE FEDERAL-AID SYSTEMS AND NON-FEDERAL-AID STATE SYSTEM

Year	Federal-aid Funds				State's Share on the Federal-aid System (Roads & Bridges)	Amount Available for Federal-aid System (Roads & Bridges)	Amount Available for Federal-aid Secondary System (Roads & Bridges)	Amount Available for Non-Federal-aid System (Roads & Bridges)	Amount Available for Construction (Roads & Bridges)	Maintenance	Total Available for Construction and Maintenance
		Roads and Bridges									
	Grade Crossings (1)	Federal-aid System (2)	Federal-aid Secondary System (3)	Total (4) Cols.1+2+3	(5)	(6) Col. 2+5	(7)	(8)	(9) Cols.1+6+7+8	(10)	(11) Col. 9+10
1941	$ 97,000	$ 610,000	$ 73,000	$ 780,000	$ 985,000	$ 1,595,000	$ 146,000	$ 254,000	$ 2,092,000	$ 1,370,000	$ 3,462,000
1942	97,000	488,000	85,000	670,000	733,000	1,221,000	170,000	455,000	1,943,000	1,390,000	3,333,000
1943	97,000	488,000	85,000	670,000	751,000	1,239,000	170,000	498,000	2,004,000	1,410,000	3,414,000
1944	100,000	415,000	85,000	600,000	827,000	1,242,000	170,000	469,000	1,981,000	1,430,000	3,411,000
1945	100,000	415,000	85,000	600,000	885,000	1,300,000	170,000	627,000	2,197,000	1,450,000	3,647,000
1946	100,000	415,000	85,000	600,000	957,000	1,372,000	170,000	872,000	2,514,000	1,470,000	3,984,000
1947	100,000	415,000	85,000	600,000	962,000	1,377,000	170,000	883,000	2,530,000	1,490,000	4,020,000
1948	100,000	415,000	85,000	600,000	967,000	1,382,000	170,000	894,000	2,546,000	1,510,000	4,056,000
1949	100,000	415,000	85,000	600,000	970,000	1,385,000	170,000	902,000	2,557,000	1,530,000	4,087,000
1950	100,000	415,000	85,000	600,000	1,013,000	1,428,000	170,000	1,031,000	2,729,000	1,550,000	4,279,000
Total	$991,000	$4,491,000	$838,000	$6,320,000	$9,050,000	$13,541,000	$1,676,000	$6,885,000	$23,093,000	$14,600,000	$37,693,000

(1) Grade crossing funds can be used on any system.
(2) Federal-aid funds available for roads and bridges matched by the State. For total amount including State's share see Column 6.
(3) Federal-aid secondary funds available for roads and bridges matched by the State, available on non-Federal-aid State system and State-aid system.
(4) Estimated available Federal-aid funds. (Columns 1 + 2 + 3).
(5) State's share of regular Federal-aid funds plus additional State funds. For total estimated funds for Federal-aid system see Column 6.
(6) Federal-aid funds plus State's share of regular Federal-aid plus additional State funds. (Column 2 + 5).
(7) Amount available for Federal-aid secondary system. Column 3 plus State matching funds.
(8) Amount available for non-Federal-aid State system. This amount is supplemented by Federal-aid secondary funds.
(9) Amount available for construction. (Columns 1 + 6 + 7 + 8).
(10) Maintenance.
(11) Total available for construction and maintenance on roads and bridges and construction on grade crossings. (Columns 9 + 10).

Table 25

Estimated Cost of Improving the Federal-aid System to Certain Standards

Type of Proposed Improvement	*Miles*	*Estimated Cost of Improvements*	*Total Cost*
Roads			
Hardsurfacing gravel highways	55.0	$1,449,200	
Reconstructing surface-treated gravel highways	124.7	4,729,719	
Replacing surface-treated gravel highways	45.8	845,900	
Reconstructing paved highways	142.8	7,666,375	
Replacement of macadam surface	11.3	429,800	
Widening roadbed to 32 feet and over	275.5	4,340,028	
Multiple lane construction	11.6	749,500	
Construction of Jay Mountain Highway[1]	14.7	795,500	
Improvement of intersections	0.2	37,550	
Total for road improvement	681.6		$21,043,572
Bridges	*Number*		
Reconstructing bridges 20-foot span and over	73	$2,469,500	
Reconstructing bridges less than 20-foot span	17	111,600	
Improving bridges on road projects	36	96,300	
Total for bridge improvement	126		$ 2,677,400
Total for road and bridge improvement			$23,720,972

[1] All-American Route between Troy and Richford.

$750,000 annually. The estimated available funds for improvement on Town Highways, during the forecast period, have been maintained at $750,000 through to 1949. This amount has been increased to $1,000,000 in 1950 as it is estimated that increased travel will warrant the expenditure of additional funds by that time.

Estimated Expenditures on the Federal-aid System (1941-1950 inclusive)

It is estimated that a total construction expenditure of $23,720,972 would be necessary from 1941 to 1950 to improve the Federal-aid roads and bridges to the standards previously set forth. This figure is subdivided as follows:

Roads	$21,043,572
Bridges	2,677,400
Total	$23,720,972

The expenditure of this money will improve these highways to standards that will serve traffic more adequately in the future. It will hardsurface 55.0 miles of gravel roads that will need surfacing by 1950; reconstruct with a higher type of surface 124.7 miles of surface-treated gravel highways which at the present time have a high maintenance cost because of inferior base and drainage and replace with a higher type of surface 45.8 miles of surface-treated gravel which are inadequate for the volume of traffic carried, and reconstruct 142.8 miles of paved highways which have an alignment index of 1.7 and over. It will replace 11.3 miles of macadam surface that was constructed on inferior base; widen the roadbed to 32 feet or more on 275.5 miles of highways having an 18-foot surface; construct additional lanes on 11.6 miles of highway that are at present overcrowded; construct an All-American Route 14.7 miles in length between Troy and Richford over Jay Mountain; improve certain dangerous intersections, and reconstruct and/or widen 126 bridges. These proposed improvements are shown on Map 1 and the tables in the Appendix. The estimated cost of the above items is shown in Table 25.

The total estimated funds available for this work on the Federal-aid System amount to $13,541,000, and the State lacks the required amount for the needed improvement by $10,179,972.

Estimated Expenditures on the non-Federal-aid State System (1941-1950 inclusive)

The estimated cost of improving the non-Federal-aid State System to the determined standards amounts to $12,777,383. This figure is divided into the following items:

Roads	$12,165,783
Bridges	611,600
Total	$12,777,383

The expenditure of this sum of money will make the following improvements: It will hardsurface 313.9 miles of gravel roads that should be surfaced by 1950; reconstruct 24.9 miles of surface-treated gravel that have high maintenance costs because of inferior base and drainage; reconstruct 4.9 miles of paved highways which were constructed on inferior foundations or which have an alignment index of 1.7 or more; improve one intersection; construct to present State Highway Standards 7.5 miles of State Highways, 56.7 miles of State-aid Highways and 11.8 miles of Town Highways on the Central Route, and reconstruct and/or widen 140 bridges. The estimated cost of the above items is shown in Table 26.

The total estimated funds available for this work on the non-Federal-aid State System amount to $8,561,000. The State lacks the necessary money to do this work by $4,216,383.

Expenditures on the Entire State System (including Federal-aid State-aid Connecting Links)

The total estimated expenditures necessary to make the needed improvements on roads and bridges on the Federal-aid System and non-Federal-aid State System during the next ten years amount to $36,498,355. It seems appropriate to point out here that the expenditure of this sum will not completely modernize the entire State System. Only such sections of highway as have a relatively high volume of traffic have been included. As regards curvature, sight distance, and grade, all road sections having an alignment index above zero are below the standards as set forth in this report, but only those having an alignment index of 1.7 and over have been included. Regarding bridges, only those having an index greater than the average have been included, with the exception of those included in road projects. There are also 60 bridges whose roadway width is less than 24 feet that carry a traffic of 1,000 vehicles per day or more that have not been included. The intention has been to present a program that would include only such inadequate portions of highways as prevent the free movement of traffic or which constitute dangerous hazards.

State-aid Highway Expenditures

For each of the years 1940 and 1941 the State appropriated from its motor vehicle revenue the following amounts to assist in the construction and maintenance of State-aid Highways:

Road Construction	$325,000
Bridge Construction	100,000
Maintenance	425,000
Total	$850,000

This amount is supplemented by Federal-aid Secondary funds where they can be applied. In 1940, the sum of $1,047,092 was expended for construction and maintenance on the State-aid System, exclusive of Town contributions which amounted to $76,870.

Table 26

Estimated Cost of Improving the Non-Federal-aid State System to Certain Standards

Type of Proposed Improvement	*Miles*	*Estimated Cost of Improvements*	*Total Cost*
Roads			
Hardsurfacing gravel highways	313.9	$8,001,390	
Reconstructing surface-treated gravel highways	24.9	564,993	
Reconstructing paved highways	4.9	214,400	
Replace macadam			
Widening roadbed to 32 feet and over			
Multiple lane construction			
Improvement of intersections	0.3	5,000	
Construction of Central Route (roads and bridges)	76.0	3,380,000	
Total for road improvement	420.0		$12,165,783
Bridges	*Number*		
Reconstructing bridges 20-foot span and over	29	$ 398,000	
Reconstructing bridges less than 20-foot span	37	92,900	
Widening bridges	36	51,400	
Improving bridges in road projects[1]	38	69,300	
Total for bridge improvement	140		$ 611,600
Total for road and bridge improvement			$12,777,383

[1] Ordinarily these bridges would serve traffic for a number of years to come, but because of thier inclusion in road projects it is considered more economical to improve them when the road is improved, because of changes in grade, alignment and roadway width.

Maintenance costs on the State-aid System have been gradually increasing. Increased travel and the demand for better roads during the winter have contributed to higher maintenance costs. Annual appropriations for maintenance by the State amounted to $340,000 in 1936, $375,000 in 1938, and $425,000 in 1940. It seems reasonable to assume that maintenance costs will continue to increase as the traffic increases so an approximate amount of $650,000 is estimated by 1950, or a total during the next ten years of $5,375,000.

Estimated costs for proposed needed highway improvements have been made for all unsurfaced State-aid Highways, all gravel State-aid Highways carrying 200 vehicles or more per day which it is estimated will be carrying 300 by 1950, all State-aid Connecting Links and all bridges on the State-aid Connecting Links. (See Maps 2 and 3 in the Appendix.) The estimated cost of the needed improvements on the Federal-aid State-aid Connecting Links is included under "Estimated Expenditures on the Federal-aid System."

The estimated cost of making these needed improvements on the State-aid System, exclusive of Connecting Links on the Federal-aid System, amounts to $2,029,636.

The expenditure of this amount would put a gravel surface on 128.1 miles of rural earth roads at a cost of $532,654 and hardsurface 101.5 miles of gravel roads at a cost of $773,882. On the State-aid Connecting Links it would reconstruct 6.4 miles of surface-treated gravel roads at a cost of $349,000; reconstruct 0.9 miles of paved highways at a cost of $90,600; widen the roadbed to 32 feet and over on 1.5 miles of highway at a cost of $93,500; and reconstruct 3 bridges at a cost of $190,000.

According to available data, this represents the needs of the State-aid System, exclusive of those State-aid Connecting Links on the Federal-aid System. But, in addition to this work there is the necessary continued improvements for which no data is at present available. Such work consists of rural bridge construction, improvements on State-aid Streets, and widening and improving the alignment and grade on rural State-aid roads exclusive of those mentioned above. This work is called regular State-aid Highway construction.

For construction on the State-aid System the present State appropriation is $325,000 a year. This is available under two separate funds which are used for the same purpose. The sum of $175,000 has been available to cities, towns and villages incorporated for highway purposes on the basis of $60.00 per mile for each mile of State-aid Highway; and the sum of $150,000 has been available at the rate of approximately $10.00 per mile on the basis of the total mileage of all roads and streets in cities, towns or incorporated villages.

On the basis of the present distribution of State funds there will be some cities, towns and villages where the allotment over the ten-year period will be insufficient to make these needed improvements. On rural highways an additional amount of $474,424 is needed, and on the State-aid Connecting Links an additional amount of $455,598 is necessary if these needed improvements are to be made.

This represents a total of $930,022 which is needed for road construction in addition to the present appropriations of $325,000 per year or $3,250,000 in ten years. This would amount to a grand total of $4,180,022.

Of the total amount necessary for the needed road improvements ($1,839,636), $909,614 would be available from the present regular appropriations of $3,250,000 over the ten-year period. The remaining portion of this appropriation would be used for regular construction.

The present appropriation for bridge construction amounts to $100,000 annually, or $1,000,000 over the ten-year period, and on the basis of past experience is considered adequate.

During the next ten years the following amounts will be necessary for State-aid Highways:

Road Construction	$ 4,180,022
Bridge Construction	1,000,000
Maintenance	5,375,000
Total	$10,555,022

To do this necessary work on the State-aid System will require an estimated expenditure of $10,555,022. The total funds available for this work are estimated at $10,075,000, so the State lacks the required amount by $480,022. Of the $10,075,000 it is estimated that $5,375,000 will be needed for maintenance, leaving a total of $4,700,000 for the construction of roads and bridges.

Town Road Expenditures

The State assists the towns by appropriating from its motor vehicle revenues up to $750,000 per year; this is used for construction and maintenance on Town Highways and is available in two amounts: $500,000 is available as an outright grant, and $250,000 is available if the towns spend a similar amount. **The total amount of State funds and town matching funds, spent for construction and maintenance on Town Highways each year amounts to approximately $1,000,000.** An increase of $250,000 has been estimated for 1950. (See Table 23, page 59.)

According to legislative acts one-fifth of the available State funds may be set aside for winter maintenance, and one-third of any year's allotment from the State may be used for the building and repairing of bridges. During 1939 approximately $20,000 of State funds was expended for building and repairing bridges and during the winter of 1939 and 1940 about $39,000 of State funds was expended for winter maintenance. It is estimated on the basis of past experience that these amounts will be sufficient for the succeeding ten years.

The estimated available State funds for town roads during the next ten years amounts to $7,750,000 (see Table 23). Deducting the amounts estimated for winter maintenance, and

building and repairing bridges leaves a balance of $7,160,000 for the construction of town roads.

From the records compiled from town claims, and estimates made by the district highway commissioners, it is possible to establish an approximate cost per mile of surfacing Town Highways with gravel together with such widening and improvements in alignment as may be necessary. Costs differ in different sections of the State and on various roads, depending upon the availability of material and type of improvement. But the average estimated cost of improvement is approximately $2,500 per mile. If $7,160,000 were used for the improvement of Town Highways on the basis of $2,500 per mile it would be possible to improve approximately 2,900 miles of earth road from 1941 to 1950.

A field inventory shows that during 1939, approximately 267 miles of town road was improved as follows:

0.4 miles improved to a high surface type
4.5 miles improved to an intermediate surface type
261.9 miles improved to a gravel surface

266.8 total miles improved

Estimated Expenditures on Railroad Grade Crossings, Overpasses, and Underpasses.
(1941-1950 inclusive.)

Under the present policy only a small percentage of State funds have been used for the elimination of grade crossings and the improvement of highway overpasses and underpasses where the primary purpose has been to eliminate the crossing or improve the overpass or underpass. In most instances such funds as were used have been outright Federal-aid grants. To such funds the State adds about 20 percent which is used for right-of-way and preliminary engineering.

The total estimated expenditures to make the proposed improvements on grade crossings, overpasses, and underpasses on the State System and State-aid Connecting Links during the next ten years amounts to $5,753,000. This amount is subdivided as shown in Table 27.

It is estimated that there will be available for this work during the next ten years approximately $991,000 (see Table 24, Column 1, page 59) so the State lacks the necessary amount by $4,762,000.

Although grade crossings interrupt the free movement of traffic and present certain hazards, it may not be economically practicable to consider for elimination and improvement, all those estimated, particularly those in municipalities. In many places, where the volume of traffic warrants, it may be feasible to relocate the highway or construct alternate routes.

Table 27

Estimated Cost of Improving Grade Crossings, Overpasses and Underpasses to Certain Standards

System	*Number*	*Estimated Cost for Improvement*	*Total*
Grade Crossings			
State	21	$2,390,000	
State-aid Connecting Links	8	1,525,000	$ 3,915,000
Underpasses			
State	12	$ 840,000	
State-aid Connecting Links	3	415,000	1,255,000
Overpasses			
State	3	$ 225,000	
State-aid Connecting Links	2	214,000	439,000
Installation of Flash Signals			
State	......	$ 72,000	
State-aid System	......	72,000	144,000
Total Cost			$ 5,753,000

PROPOSED TEN-YEAR PROGRAM

State System[1] (***Roads and Bridges***)

On a pay-as-you-go policy it is not possible to realize all the needed improvements for the State System as has previously been presented, unless the present road user taxes are increased. At the present rate of taxing motor vehicles this program must be modified to come within the estimated available revenue of $22,102,000 for roads and bridges. (See Columns 6, 7, and 8, Table 24, page 59.)

Proceeding upon this basis the number of miles of inadequate roads and bridges, which the State can improve with available funds, have been selected for inclusion in a ten-year program. In selecting such a program there are two types of improvement which it is essential to make during the next ten years. (1) All gravel roads that will be carrying 300 vehicles or more by 1950 should be hardsurfaced; and (2), all surface-treated gravel and macadam roads having an inferior foundation, and all surface-treated gravel roads having a good foundation but carrying an excessive traffic volume should be improved to a higher type of surface.

The estimated money available for this work on the Federal-aid System amounts to $13,541,000 during the next ten years. The expenditure of this amount will hardsurface 55.0 miles of gravel highways, reconstruct with a higher type of surface 89.6 miles of surface-treated gravel highways; replace with a higher type of surface 34.2 miles of surface-treated gravel highways; and reconstruct 55.1 miles of paved highways. It will replace 11.3 miles of macadam surface; widen the roadbed to 32 feet or more on 10.1 miles of highways; construct additional lanes on 3.6 miles of highway; improve one intersection; construct an All-American Route, 14.7 miles in length between Troy and Richford; and reconstruct and/or widen 85 bridges.

These needed improvements are shown on Map 4 in the Appendix. The estimated cost of the above items is shown in Table 28 below.)

On the non-Federal-aid State System and Federal-aid Secondary System it is estimated that $8,561,000 will be available for construction during the next ten years. (See Table 24, Columns 7 and 8, page 59.) **The expenditure of this amount will hardsurface 294.0 miles of gravel highways; reconstruct 15.4 miles of surface-treated gravel highways; reconstruct 1.0 mile of paved highway; and improve 113 bridges.**

Table 28

Estimated Cost of Improving the Federal-aid System (1941-1950) with Estimated Available Funds

Type of Proposed Improvements	*Miles*	*Estimated Cost of Improvements*	*Total Cost*
Roads			
Hardsurfacing gravel highways	55.0	$1,449,200	
Reconstructing surface-treated gravel highways	89.6	3,939,719	
Replacing surface-treated gravel highways	34.2	640,200	
Reconstructing paved highways	55.1	3,592,381	
Replacement of macadam	11.3	429,800	
Widening roadbed to 32 feet or more	10.1	519,000	
Multiple lane construction	3.6	300,000	
Construction of Jay Mountain Highway	14.7	795,500	
Improvement of intersections	0.1	30,000	
Total for Roads	273.7		$11,695,800
Bridges			
Improving 85 bridges			1,845,200
Total for Road and Bridge Improvement			$13,541,000

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[1] Includes Federal-aid State-aid Connecting Links.

NEEDED HIGHWAY IMPROVEMENTS IN VERMONT—1941-1950

Table 29

Estimated Cost of Improving the Non-Federal-aid State System[1] (1941-1950) with Estimated Available Funds

Type of Proposed Improvement	*Miles*	*Estimated Cost of Improvements*	*Total Cost*
Roads			
Hardsurfacing gravel highways	294.0	$7,611,650	
Reconstructing surface-treated gravel highways	15.4	337,450	
Reconstructing paved highways	1.0	38,000	
Total for Roads	310.4		$ 7,987,100
Bridges			
Improving 113 bridges			573,900
Total for Road and Bridge Improvement			$ 8,561,000

[1] Includes Federal-aid Secondary System.

These needed improvements are shown on Map 4 in the Appendix. The estimated cost of the above items is shown in Table 29 above.

In the selection of this program it is not considered economically practicable at this time to include all highway sections and bridges that have the highest indices or ratings. Many of the worst sections would involve a cost out of all proportion to the justification for improvement. Some of these sections are located in small villages and some on the open highway where the improvement necessitates long and costly relocations. On the other hand, many sections that are adequate are included because of flood conditions and it is also necessary to rebuild many bridges having a low deficiency index because of their inclusion in road projects.

It should be borne in mind that changing conditions, unforeseen decreases in highway revenues and abnormal changes in traffic may make it necessary to alter parts of the proposed program during the next ten years.

*State-aid System (**Roads and Bridges**)*

It is estimated that approximately $4,700,000 will be available for the improvement of roads and bridges on the State-aid System during the next ten years. The expenditure of this money will put a gravel surface on 101 miles of unsurfaced highway; hardsurface 71 miles of gravel highway; improve 1.5 miles of superior to gravel surface on the State-aid Connecting Links; improve 550 miles of State-aid Highways through regular State-aid construction; and improve approximately 200 bridges.

The estimated cost of the above work is shown in Table 30 below.

*Town System (**Roads and Bridges**)*

It is estimated that approximately $7,160,000 will be available for the improvement of roads on the Town System. (See page 63.) The expenditure of this money would improve about 2,900 miles of Town Road during the next ten years. If the roads in each town selected for improvement with State money are selected on the basis of serving the maximum number of dwellings, approximately all unsurfaced roads having a dwelling density of 1.0 or more houses per mile could be surfaced by 1950. This would include all the unsurfaced mileage (earth roads) now serving a traffic volume over 10 vehicles per day.

On the basis of the present study of Town Roads it is estimated that with the proper selec-

Table 30

Estimated Cost of Improving the State-aid System (1941-1950) with Estimated Available Funds

Type of Improvement	*Miles*	*Estimated Cost of Improvements*	*Total Cost*
Gravel surfacing earth highways	101	$ 405,818	
Hardsurfacing gravel highways	71	441,719	
Improving superior to gravel highways	1.5	82,263	
Regular State-aid Highway construction	550	2,770,200	
Improving 200 bridges		1,000,000	
Total Roads and Bridges			$ 4,700,000

tion of roads to be improved, over 90 percent of the dwellings on Town Roads will be served by gravel roads by 1950.

It has been previously shown (page 48) that if the mileage of Town Roads to be improved had been selected so as to serve the greatest number of dwellings, 77.0 percent of the rural dwellings would have been directly served by gravel roads as compared to the 57.5 percent now served. Before the additional funds are appropriated for this purpose the State should be satisfied that the maximum number of rural residents are receiving the proper benefits from the present appropriations.

On the basis of past experience it is estimated that the sum of $200,000 will be adequate for the building and repairing of bridges over the ten-year period. This amount will improve approximately 200 bridges on the Town System.

Railroad Grade Crossings, Overpasses and Underpasses

In view of the expected continued appropriations from the Federal Government for the improvement of grade crossings and grade crossing structures, and because of the greater need of funds for road construction, no State funds have been programmed for such improvements.

It is estimated that there will be approximately $991,000 available in Federal-aid grants for such work during the next ten years. Under the present policy of using only Federal-aid grants for this type of work, it will be possible for the State to realize only a small portion of the needed program.

This work would include eliminating grade crossings, rebuilding underpasses and overpasses and installing flash signals.

Those grade crossings and grade crossing structures having the greatest deficiencies will be selected for improvement first if conditions are favorable. These needed improvements on the State System and State-aid Connecting Links are shown on Maps 1 and 2, respectively, in the Appendix and Tables 15, 16, and 17.

APPENDIX

Glossary

Alignment Index. A figure expressing the relation of restricted sight distance, excessive curves, and excessive grades, with regard to traffic and indicates the relative need of improvement or deficiency of any one road section in comparison with all others. Deficient sections of highway are shown by a red band on Map 1 in the Appendix.

Average 24-hour Traffic. The total number of motor vehicles per year, passing over a given road section, divided by 365 days.

Bridge. A bridge having a span length of 6 feet or more.

Deficiency Index. A figure for grade crossings or structures indicating relative inadequacy of any one crossing or structure in relation to all others, based on consideration of physical dimensions and traffic volume.

Highway Revenue. All money received from motor fuel taxes, registration fees, operators' licenses, town assessments, and Federal-aid.

High Type Surface. Bituminous surface on concrete, concrete and all types of macadam.

Intermediate Type Surface. Gravel mixed-in-place and surface-treated gravel.

Low Type Surface. Gravel.

Multiple Lane Highways. Any highway consisting of more than two lanes.

Paved Highways. Concrete, macadam and gravel-mixed-in-place.

Road User Taxes. All money received by the State from the users of highways: *viz.*, motor fuel taxes, registration fees, and operators' licenses.

Rural. Those sections outside the boundaries of cities, incorporated villages and unincorporated urban areas.

Sight Distance. The distance throughout which a driver has an unobstructed view of the road ahead, at any particular point on a highway.

Surfaced Road. A road whose original surface of natural earth has been improved by a course of some superior material such as gravel, crushed stone, etc., usually gravel.

Surface Types

Bituminous Surface on Concrete. A bituminous wearing course, one inch of more in compacted thickness on a concrete base.

Brick. A course of vitrified paving brick, with or without a bituminus mat less than one inch in compacted thickness.

Concrete. Portland cement concrete, with or without a bituminous mat less than one inch in compacted thickness.

Graded and Drained. Natural earth, aligned and graded to permit reasonably convenient use by motor vehicles, drained by longitudinal and transverse drainage systems, natural or artificial, sufficiently to prevent serious impairment of the road by surface water.

Granite Block. A course of stone block, with or without a bituminous mat less than one inch in compacted thickness.

Gravel, M. I. P. or Bituminous Mix. A course, one inch or more in compacted thickness, composed of gravel and bituminous material, mixed in place by means of drag, retread mixer, or blade grader.

Gravel, Plain. A course of gravel, or other similar fragmental material coarser than sand.

Gravel, Surface Treated. A course of gravel or other similar fragmental material coarser than sand, to which has been added by any process a surface mat of bituminous material and mineral aggregate less than one inch in compacted thickness.

Macadam, M. I. P. A course, one inch or more in compacted thickness, composed of crushed stone and bituminous material, mixed in place by means of drag, retread mixer, or blade grader.

Macadam Penetration. A wearing course of crushed stone, one inch or more in compacted thickness, bound with bituminous material introduced by downward penetration, on a base course.

Primitive. An unimproved route on which there is no public maintenance, usable by four-wheel vehicles and publicly traveled by small numbers of vehicles.

Rock Asphalt. A natural mined rock asphalt.

Unimproved Earth. A surface composed wholly or with minor local exceptions of the natural ground of the region, and on which the only work that has been done by public authority is that required to maintain a condition of passability for horse-drawn or motor vehicles.

Surface Type Index. A figure expressing the relative need of improvement in surface type, with regard to traffic, of any one road section in comparison with all others. Deficient surface types are shown by a yellow band on Map 1 in the Appendix.

Surface Width Index. A figure expressing the relative need of surface widening, with regard to traffic, of any one road section in comparison with all others. Surfaces deficient in width are shown by means of a blue band on Map 1 in the Appendix.

Traffic Volume. Average 24-hour traffic, also referred to as average daily traffic.

Urban. Those sections within the boundaries of cities, incorporated villages and unincorporated urban areas.

Unsurfaced Road. A road whose riding surface consists of the natural earth.

Vehicle-miles. The total number of miles travelled by all vehicles over a given road or groups of roads. Unless otherwise specified, the term means average 24-hour vehicle-miles, or annual vehicle-miles divided by 365.

TABLE A.

ANNUAL MOTOR VEHICLE REGISTRATIONS, OPERATORS LICENSED, MOTOR FUEL CONSUMPTION AND POPULATION HISTORIC TO 1940, FORECAST TO 1950

Year	Population in thousands	Motor Vehicle Registrations				Motor Fuel Consumption	Operators Licensed [1]
		Passenger	Trucks	Busses	Total		
	Number	Number	Number	Number	Number	1000 gal.	Number
Historic							
1906	351	-	-	-	373	-	-
1907	353	-	-	-	-	-	-
1908	354	-	-	-	489	-	-
1909	355	-	-	-	1,741	-	-
1910	356	-	-	-	2,570	-	-
1911	355	-	-	-	3,402	-	-
1912	355	-	-	-	4,487	-	-
1913	355	-	-	-	5,913	-	-
1914	354	-	-	-	8,475	-	-
1915	354	-	-	-	11,499	-	14,344
1916	354	-	-	-	15,671	-	19,727
1917	353	19,101	1,266	-	20,367	-	23,359
1918	353	20,782	1,873	-	22,655	-	27,980
1919	353	24,405	2,402	-	26,807	-	33,597
1920	352	28,442	3,183	-	31,625	-	39,201
1921	352	33,778	3,487	-	37,265	-	44,987
1922	354	41,241	2,640	-	43,881	-	51,703
1923	355	49,420	3,356	-	52,776	4,654	59,507
1924	356	57,072	4,107	-	61,179	20,578	67,567
1925	356	64,566	5,010	-	69,576	24,928	74,093
1926	357	68,431	5,539	93	74,063	25,503	79,586
1927	358	73,174	6,219	134	79,527	30,856	86,309
1928	358	78,574	7,546	111	86,231	33,678	89,606
1929	359	84,321	8,559	150	93,030	40,797	95,387
1930	360	78,260	8,226	138	86,624	45,738	97,699
1931	360	74,842	8,514	151	83,507 [2]	47,869	97,643 [2]
1932	360	68,640	8,406	139	77,185	49,148	93,702
1933	360	62,553	7,725	113	70,391	45,438	88,405
1934	359	72,017	8,516	94	80,627	46,153	98,650
1935	359	71,130	9,026	89	80,245	49,365	98,254
1936	359	77,049	8,884	114	86,047	54,866	104,994
1937	359	79,433	9,375	105	88,913	60,468	108,252
1938	359	78,676	9,026	106	87,808	64,235	109,646
1939	359	80,585	9,590	95	90,270	64,621	111,989
1940	359	83,540	9,804	96	93,440	69,179	115,342
Forecast							
1941	359	83,209	9,891	100	93,200	71,831	116,600
1942	359	86,235	10,345	100	96,680	74,057	118,200
1943	359	87,423	10,487	100	98,010	75,468	119,200
1944	359	88,405	10,605	100	99,110	76,810	120,000
1945	359	89,069	10,796	100	99,965	77,727	121,000
1946	359	89,421	10,839	100	100,360	78,582	121,800
1947	359	89,633	10,977	100	100,710	79,057	122,500
1948	360	89,768	11,107	100	100,975	79,467	123,100
1949	360	89,881	11,234	100	101,215	79,960	123,600
1950	360	90,040	11,305	100	101,445	80,344	124,100

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[1] Operators Licensed also includes Junior Operators.

[2] Prior to 1931 for calendar year; 1931 and after for fiscal year.

TABLE B.

INTERRELATIONSHIPS BY YEARS OF POPULATION, MOTOR VEHICLE REGISTRATIONS, OPERATORS LICENSED, AND MOTOR FUEL CONSUMPTION HISTORIC TO 1940, FORECAST TO 1950

Year	Persons per Registered Motor Vehicle			Motor Fuel Consumption per Motor Vehicle Registered	Persons per Licensed Operator	Commercial Vehicles to Total Vehicles
	All Vehicles	Passenger	Trucks			
	Number	Number	Number	Gallons	Number	Percent
Historic						
1906	941	-	-	-	-	-
1907	941	-	-	-	-	-
1908	724	-	-	-	-	-
1909	331	-	-	-	-	-
1910	138.5	-	-	-	-	-
1911	104.4	-	-	-	-	-
1912	79.1	-	-	-	-	-
1913	60.0	-	-	-	-	-
1914	41.8	-	-	-	-	-
1915	30.8	-	-	-	24.7	-
1916	22.6	-	-	-	17.9	-
1917	17.3	18.5	278.8	-	15.1	6.2
1918	15.6	17.0	188.5	-	12.6	8.3
1919	13.2	14.5	147.0	-	10.5	9.0
1920	11.1	12.4	110.6	-	9.0	10.1
1921	9.4	10.4	101.0	-	7.8	9.4
1922	8.1	8.6	134.0	-	6.8	6.0
1923	6.7	7.2	105.8	88	6.0	6.4
1924	5.8	6.2	86.7	336	5.3	6.7
1925	5.1	5.5	71.1	358	4.8	7.2
1926	4.8	5.2	64.5	344	4.5	7.6
1927	4.5	4.9	57.6	388	4.2	8.0
1928	4.2	4.6	47.4	391	4.0	8.9
1929	3.9	4.3	41.9	439	3.8	9.4
1930	4.2	4.6	43.8	528	3.7	9.7
1931	4.3	4.8	42.3	573	3.7	10.4
1932	4.7	5.3	42.8	637	3.8	11.1
1933	5.1	5.8	46.6	646	4.1	11.1
1934	4.5	5.0	42.2	572	3.6	10.7
1935	4.4	5.0	39.8	615	3.7	11.4
1936	4.2	4.7	40.4	638	3.4	10.5
1937	4.0	4.5	38.3	680	3.3	10.7
1938	4.1	4.6	39.7	732	3.3	10.4
1939	4.0	4.4	37.3	716	3.2	10.7
1940	3.8	4.3	36.5	740	3.1	10.6
Forecast						
1941	3.8	4.3	36.2	755	3.2	10.7
1942	3.7	4.2	34.6	766	3.1	10.8
1943	3.7	4.1	34.2	770	3.1	10.8
1944	3.6	4.1	33.9	775	3.1	10.8
1945	3.6	4.0	33.3	778	3.0	10.9
1946	3.6	4.0	33.1	783	3.0	10.9
1947	3.6	4.0	32.7	785	3.0	11.0
1948	3.6	4.0	32.4	787	3.0	11.1
1949	3.6	4.0	32.0	790	2.9	11.2
1950	3.6	4.0	31.8	792	2.9	11.2

TABLE C.

PERCENT OF POPULATION, MOTOR VEHICLE REGISTRATIONS, MOTOR FUEL CONSUMPTION, MILES PER GALLON, VEHICLE MILES, AND COMMERCIAL VEHICLES TO TOTAL VEHICLES TO 1937 VALUES HISTORIC TO 1940, FORECAST TO 1950

Year	Population	Vehicles per 100 persons	Motor Fuel Consumption	Miles per Gallon	Vehicle Miles	Commercial to Total
	Percent	Percent	Percent	Percent	Percent	Percent
Historic						
1906	97.77	0.43	-	-	-	-
1907	98.32	0.43	-	-	-	-
1908	98.61	0.55	-	-	-	-
1909	98.89	1.21	-	-	-	-
1910	99.16	2.89	-	-	-	-
1911	98.89	3.83	-	-	-	-
1912	98.89	5.05	-	-	-	-
1913	98.89	6.67	-	-	-	-
1914	98.61	9.57	-	-	-	-
1915	98.61	12.99	-	-	-	-
1916	98.61	17.70	-	-	-	-
1917	98.33	23.12	-	-	-	57.94
1918	98.33	25.64	-	-	-	77.57
1919	98.33	30.30	-	-	-	84.11
1920	98.05	36.04	-	-	-	94.39
1921	98.05	42.55	-	-	-	87.85
1922	98.61	49.38	-	-	-	56.07
1923	98.89	59.70	12.94	-	-	59.81
1924	99.16	68.97	49.41	73.46	24.82	62.62
1925	99.16	78.43	52.65	75.50	30.91	67.29
1926	99.44	83.33	50.59	77.54	32.51	71.03
1927	99.72	88.89	57.06	79.58	40.25	74.77
1928	99.72	95.24	57.50	81.62	44.57	83.18
1929	100.00	102.56	64.56	83.66	55.39	87.85
1930	100.28	95.24	77.65	85.70	63.56	90.65
1931	100.28	93.02	84.26	87.74	68.96	97.20
1932	100.28	85.11	93.68	89.78	71.78	103.74
1933	100.28	78.43	95.00	91.82	68.61	103.74
1934	100.00	88.89	84.12	93.86	70.18	100.00
1935	100.00	90.91	90.44	95.90	78.85	106.54
1936	100.00	95.24	93.82	97.95	87.52	98.13
1937	100.00	100.00	100.00	100.00	100.00	100.00
1938	100.00	97.56	107.65	101.10	105.88	97.20
1939	100.00	100.00	105.29	102.20	107.31	100.00
1940	100.00	105.26	108.82	102.35	116.91	99.07
Forecast						
1941	100.00	105.26	111.03	102.50	119.46	100.00
1942	100.00	108.11	112.65	102.65	124.66	100.00
1943	100.00	108.11	113.24	102.85	125.91	100.93
1944	100.00	111.11	113.97	103.00	130.43	100.93
1945	100.00	111.11	114.41	103.15	131.12	101.87
1946	100.00	111.11	115.15	104.08	133.16	101.87
1947	100.00	111.11	115.44	105.18	134.91	102.80
1948	100.28	111.11	115.74	107.10	138.11	103.74
1949	100.28	111.11	116.18	109.10	141.23	104.67
1950	100.28	111.11	116.47	111.51	144.71	104.67

TABLE D.

BRIDGES LESS THAN 20-FOOT SPAN ON THE STATE SYSTEM THAT REQUIRE RECONSTRUCTION

County	Route	Town	Station /1	Type	Span	Loading Capacity	Horizontal Clearance	Average 24-Hour Traffic 1937	Estimated 1945	Estimated 1950	Estimated Cost of Improvement	Class /2
					Feet		Feet	Vehicles	Vehicles	Vehicles		
Addison	Vt. F-10	Orwell	7 + 78	I-Beam	14	H-10	21	200	262	290	$3,000*	1
	Vt. 115	Goshen	50 + 65	Plank Stringer	7	H-10	17	200	262	290	2,000*	1
	Vt. 125	Hancock	73 + 67	I-Beam	11	H-10	16	170	223	247	2,500*	1
	Vt. 125	Ripton	3 + 29	Log Stringer	6	H-10	22	180	236	261	1,000*	1
Bennington	Vt. 11	Winhall	101 + 01 FA	Log Stringer	16	H-10	18	375	491	544	5,000*	1
Caledonia	Vt. 114	Newark	277 + 29	Log Stringer	6	H-10	15	150	197	218	1,000*	1
Essex	Vt. 102	Lemington	133 + 35	Log Stringer	19	H-10	23	200	262	290	4,000*	1
	Vt. 114	Canaan	73 + 57	Log Stringer	6	H-10	18	200	262	290	1,200*	1
	Vt. 114	Canaan	85 + 02	Log Stringer	11	H-10	20	200	262	290	2,000*	1
Lamoille	Vt. 118	Belvidere	161 + 52	Log Stringer	6	H-10	22	150	197	218	1,500*	1
Orange	Vt. 113	Chelsea	66 + 77	Log Stringer	17	H-10	15	175	229	254	3,000*	1
	Vt. 113	Chelsea	73 + 77	Log Stringer	14	H-10	14	175	229	254	3,000*	1
	Vt. 113	Chelsea	97 + 78	Log Stringer	15	H-10	15½	175	229	254	3,000*	1
	Vt. 113	Chelsea	113 + 27	Log Stringer	14	H-10	15	175	229	254	3,000*	1
	Vt. 113	Chelsea	120 + 02	Log Stringer	12	H-10	14	175	229	254	3,000*	1
	Vt. 113	Chelsea	141 + 92	I-Beam	18½	H-10	18	175	229	254	4,000*	1
	Vt. 25	Topsham	233 + 59	I-Beam	12	H-10	20	350	459	508	3,000*	1
	Vt. 25	Topsham	272 + 88	Plank	6	H-10	19½	350	459	508	1,500*	1
Orleans	Vt. 100	Lowell	76 + 52 FA	Log Stringer	9	H-10	20	250	328	363	1,200*	1
	Vt. 100	Lowell	342 + 74 FA	Log Stringer	8	H-10	20	300	393	435	1,000*	1
Rutland	U.S. 4	Mendon	177 + 75 FA	Arch	11	H-10	20	1000	1310	1450	6,000*	1
	Vt. 30-A	Benson	317 + 87	Plank Stringer	6	H-10	20	270	354	392	1,500*	1
Washington	Vt. 100	Warren	134 + 19	Log Stringer	8½	H-10	20	190	249	276	1,800*	1
Windsor	Vt. 100	Plymouth	242 + 69	I-Beam	17	H-10	18	210	275	305	2,500*	1
	Vt. 12	Hartland	131 + 10	Plank Stringer	7	H-10	18	375	491	544	2,000*	1

* Included in Proposed Ten Year Program.

1/ Stations refer to straight line diagrams. Federal-aid is indicated by FA.

2/ Classified in order of importance by the Bridge Department.
Class 1. Inadequate for traffic because of capacity, alignment, or narrow roadway.

TABLE D. (CONTINUED)

BRIDGES LESS THAN 20-FOOT SPAN ON THE STATE SYSTEM THAT REQUIRE RECONSTRUCTION

County	Route	Town	Station /1	Type	Span	Loading Capacity	Horizontal Clearance	Average 24-Hour Traffic			Estimated Cost of Improvement	Class /2
									Estimated			
								1937	1945	1950		
					Feet		Feet	Vehicles	Vehicles	Vehicles		
Bennington	Vt. 67	Shaftsbury	1 + 64	Concrete I-Beam	19	H-15	19	400	524	580	$ 4,000*	2
	Vt. 67	Shaftsbury	35 + 77	Concrete	17	H-15	16½	400	524	580	4,000*	2
Chittenden	U.S. 7	Shelburne	34 + 00 FA	Slab	10	H-15	20	1950	2555	2828	5,000*	2
Essex	U.S. 2	Lunenburg	108 + 01 FA	Arch	9	H-15	20	750	983	1088	4,000*	2
	U.S. 2	Concord	366 + 96 FA	Stone	12	H-15	20	750	983	1088	3,000*	2
Franklin	Vt. 118	Montgomery	45 + 25	Slab	13½	H-10	20	150	197	218	3,000*	2
	Vt. 118	Berkshire	37 + 89	Box	10	H-15	20	500	655	725	1,200*	2
	Vt. 118	Berkshire	42 + 16	Box	12	H-15	20	500	655	725	1,200*	2
Orange	U.S. 5	Newbury	282 + 92 FA	Concrete	16	H-15	20	850	1114	1233	5,000*	2
Rutland	Vt. 103	Shrewsbury	166 + 67 FA	Arch	11	H-15	20	1175	1539	1704	50,000*	2
	Vt. 100	Sherburne	24 + 96 FA	Slab	15	H-15	18	450	590	653	3,000*	2
Washington	U.S. 2	E.Montpelier	143 + 46 FA	Slab	9	H-15	20	1250	1638	1813	1,200*	2
	U.S. 2	Middlesex	283 + 97 FA	Slab	11	H-15	20	2200	2882	3190	2,000*	2
	Vt. 12	Woodbury	35 + 50	Slab	10	H-15	20	375	491	544	3,000*	2
	Vt. 12	Woodbury	54 + 98	Slab	12	H-15	20	375	491	544	3,000*	2
Windham	U.S. 5	Brattleboro	242 + 16 FA	Arch	15	H-15	20	2200	2882	3190	6,000*	2
	U.S. 5	Dummerston	270 + 40 FA	Stone Box	6	H-15	20	1750	2293	2538	1,200*	2
Windsor	Vt. 100A	Plymouth	80 + 20	I-Beam	11	H-10	19	250	328	363	2,000*	2
	Vt. 100A	Plymouth	104 + 17	I-Beam	11	H-10	17½	250	328	363	2,000*	2
	Vt. 100A	Plymouth	122 + 70	I-Beam	18½	H-10	18	250	328	363	3,500*	2
	Vt. 106	Woodstock	27 + 73	Slab	12	H-15	18½	160	210	232	2,000*	2
	Vt. 106	Woodstock	181 + 48	Arch	16	H-15	17	300	395	435	3,500*	2
	Vt. 12	Hartland	88 + 30	Box	10	H-15	15	375	491	544	2,000*	2
	Vt. 12	Pomfret	73 + 71	Slab	18	H-15	18½	300	393	435	4,000*	2
	Vt. 12	Barnard	14 + 18	Concrete	10	H-15	18	300	393	435	3,000*	2

* Included in Proposed Ten Year Program.

1/ Stations refer to straight line diagrams. Federal-aid is indicated by FA.

2/ Classified in order of importance by the Bridge Department.
Class 2. Inadequate because of alignment or narrow roadway.

TABLE E.

BRIDGES ON THE STATE SYSTEM LESS THAN 20-FOOT SPAN AND LESS THAN 20-FOOT ROADWAY THAT REQUIRE WIDENING

County	Route	Town	Station /1	Type	Span	Loading Capacity	Horizontal Clearance	Average 24-Hour Traffic			Estimated Cost of Improvement	Class /2
									Estimated			
								1937	1945	1950		
					Feet		Feet	Vehicles	Vehicles	Vehicles		
Addison	Vt. 30-A	Bridport	307 + 61	Concrete Slab	14	H-15	18	225	295	326	$1,000*	3
	Vt. 30-A	Addison	40 + 83	Concrete Slab	8	H-15	18	225	295	326	800*	3
	Vt. 19	Cornwall	152 + 56	Stone Box	13	H-15	17	220	288	319	2,000	3
	Vt. 116	Starksboro	58 + 73	Concrete Box	7	H-15	19½	300	393	435	800	3
Bennington	Vt. 30	Winhall	85 + 11	Concrete Slab	15	H-15	19	125	164	181	1,000	3
Chittenden	Vt. 116	Hinesburg	175 + 14	Concrete Slab	7	H-15	17	300	393	435	800	3
	Vt. 116	Williston	28 + 48	Concrete Slab	12½	H-15	19	300	393	435	1,000	3
Essex	Vt. 114	Brighton	124 + 52	Concrete Slab	10	H-15	18	150	197	218	1,000	3
	Vt. 114	Canaan	87 + 87	Concrete Slab	10	H-15	18	200	262	290	1,000*	3
Franklin	Vt. 108	Bakersfield	414 + 80	I-Beam	18½	H-15	18	200	262	290	1,500*	3
Lamoille	Vt. 108	Stowe	213 + 20	Concrete Slab	13	H-15	17½	175	229	254	1,500	3
	Vt. 108	Stowe	229 + 13	Concrete Slab	8½	H-15	17½	175	229	254	1,000	3
	Vt. 108	Stowe	248 + 75	Concrete Slab	8½	H-15	18	175	229	254	1,000	3
	Vt. 108	Stowe	406 + 30	Concrete Slab	12	H-15	18	100	131	145	1,500	3
	Vt. 108	Stowe	456 + 23	Concrete Slab	17½	H-15	18	100	131	145	1,500	3
Orange	Vt. 113A	Thetford	158 + 10	Stone Box	6	H-15	18	200	262	290	1,200	3
	Vt. 113	West Fairlee	5 + 63	Concrete Slab	15	H-15	18	250	328	363	2,000	3
	Vt. 113	Vershire	7 + 04	Concrete Slab	10	H-15	18	150	197	218	1,500	3
	U.S. 302	Newbury	108 + 88 FA	Granite Box	6	H-15	18	500	655	725	1,500*	3
	Vt. 110	Washington	73 + 87	Concrete Slab	15	H-15	18	250	328	363	1,000	3
	Vt. 110	Washington	93 + 87	Concrete Slab	14	H-15	18	250	328	363	900	3
Orleans	Vt. 12	Barton	4 + 03	Granite Slab	9	H-15	18	400	524	580	2,000	3
	Vt. 12-B	Craftsbury	413 + 47	Stone Bridge	13	H-15	16	200	262	290	1,200	3
	Vt. 5-A	Westmore	279 + 88	I-Beam	14½	H-15	19½	400	524	580	800*	3
Windham	Vt. 8	Whitingham	65 + 81	Concrete Slab	9	H-15	17	300	393	435	1,000*	3
	Vt. 8	Wilmington	20 + 35	Concrete Box	8	H-15	18	300	393	435	1,000*	3
	Vt. 8	Wilmington	23 + 84	Concrete Slab	8	H-15	19	300	393	435	1,000*	3
	Vt. 8	Wilmington	48 + 07	Concrete Arch	8	H-15	19	300	393	435	1,000*	3
	Vt. 30	Townshend	329 + 71	Concrete Slab	15½	H-15	19	360	472	522	2,000*	3
	Vt. 30	Jamaica	240 + 69	Concrete Slab	15	H-15	18½	225	295	326	2,000	3
	Vt. 30	Jamaica	392 + 79	Concrete Slab	18	H-15	19	225	295	326	1,400	3
Windsor	Vt. 106	Weathersfield	289 + 69	Concrete Slab	17	H-15	18	200	262	290	3,000	3
	Vt. 106	Reading	7 + 53	Concrete Slab	17	H-15	19	225	295	326	2,500	3
	Vt. 106	Reading	185 + 70	Concrete Slab	16	H-15	16	200	262	290	3,000	3
	Vt. 106	Reading	283 + 24	Concrete Slab	10	H-15	18½	160	210	232	2,000	3
	Vt. 106	Reading	314 + 98	Concrete Slab	9	H-15	18	160	210	232	2,000	3
	Vt. 115	Rochester	348 + 30	Concrete Slab	18½	H-15	16½	160	210	232	1,500	3

* Included in Proposed Ten Year Program.

1/ Stations refer to straight line diagrams. Federal-aid indicated by FA.

2/ Classified in the order of importance by Bridge Department.
Class 3. Bridges having a roadway width less than 24 feet but otherwise adequate.

TABLE F.

BRIDGES ON THE STATE SYSTEM WHICH REQUIRE IMPROVEMENT BECAUSE OF THEIR INCLUSION IN ROAD PROJECTS /1

County	Route	Town	Station /2	HPS No. /3	Type	Span	Loading Capacity	Horizontal Clearance	Average 24-Hour Traffic			Estimated Cost of Improvement	Class /4
										Estimated			
									1937	1945	1950		
						Feet		Feet	Vehicles	Vehicles	Vehicles		
Addison	Vt. F-10	Orwell	102 + 66	-	Box	6	H-15	21	200	262	290	$ 400 *	3
	Vt. F-9	Cornwall	37 + 25	-	Box	6	H-15	20	200	262	290	600 *	3
	U.S. 7	Middlebury	33 + 89 FA	76	Truss	77	H-15	20	1300	1703	1885	20,000 *	3
	U.S. 7	Ferrisburg	69 + 30 FA	40	Truss	59	H-15	20	2000	2620	2900	15,000 *	2
	U.S. 7	Middlebury	65 + 41 FA	-	Concrete Slab	17	H-15	20	1300	1703	1885	2,500 *	3
	U.S. 7	Middlebury	193 + 19 FA	-	Concrete Box	6	H-15	22	1300	1703	1885	2,000 *	3
Bennington	Vt. 30	Rupert	40 + 10	-	Slab	9	H-15	20	350	459	508	1,000 *	3
	Vt. 30	Rupert	128 + 09	-	Slab	14	H-15	21	350	459	508	1,000 *	3
	Vt. 30	Rupert	193 + 10	-	Slab	12	H-15	20	350	459	508	1,000 *	3
	U.S. 7	Dorset	38 + 73 FA	24	Slab	24	H-15	20	1300	1703	1885	2,500 *	3
	U.S. 7	Dorset	57 + 95 FA	21	T-Beam	30	H-15	20	1300	1703	1885	4,000 *	3
	U.S. 7	Dorset	31 + 20 FA	-	Concrete Box	10	H-15	20	1300	1703	1885	1,800 *	3
	U.S. 7	Dorset	62 + 10 FA	-	Concrete Slab	13	H-15	20	1300	1703	1885	900 *	3
	U.S. 7	Dorset	76 + 34 FA	-	Concrete Slab	10	H-15	20	1300	1703	1885	1,500 *	3
	U.S. 7	Dorset	187 + 22 FA	-	Concrete Box	8	H-15	20	1300	1703	1885	1,500 *	3
	U.S. 7	Dorset	267 + 51 FA	-	Concrete Box	8	H-15	20	1300	1703	1885	900 *	3
	U.S. 7	Dorset	275 + 23 FA	-	Concrete Box	7	H-15	20	1300	1703	1885	1,000 *	3
Chittenden	U.S. 2	Bolton	232 + 70 FA	-	Concrete Box	6	H-15	20	1600	2096	2320	1,000*	3
	U.S. 2	Richmond	17 + 22 FA	-	Concrete Slab	7	H-15	20	1600	2096	2320	3,000*	3
	U.S. 2	Richmond	123 + 92 FA	-	Cattle Pass	6	H-15	20	1600	2096	2320	700*	3
	U.S. 7	Colchester	212 + 39 FA	-	Concrete Box	8	H-15	20	2200	2882	3190	2,000*	3
Franklin	Vt. 108	Bakersfield	373 + 45	8	I-Beam	22	H-15	20	200	262	290	5,000*	2
	Vt. 108	Bakersfield	408 + 86	9	T-Beam	26	H-15	20	200	262	290	2,000*	3
	Vt. 108	Enosburg	46 + 64	29	Slab	36.5	H-15	20	225	295	326	3,000*	3
	Vt. 108	Enosburg	9 + 99	-	Slab	10½	H-15	21	225	295	326	1,000*	3
	Vt. 108	Enosburg	27 + 02	-	Arch	10	H-15	21	225	295	326	1,000*	3
	Vt. 104	Fairfax	729 + 90 FA	42	Slab	24	H-15	20	150	197	218	2,000*	3
	Vt. 105	Sheldon	203 + 38 FA	-	Concrete Box	10	H-15	20	700	917	1015	10,000*	3
Lamoille	Vt. 100-C	Johnson	208 + 34 FA	-	Metal Pipe	6	H-15	20	275	360	399	4,000*	2
	Vt. 100	Eden	330 + 43 FA	-	Concrete Box	16	H-15	20	250	328	363	1,200*	3
Orange	Vt. 25	Topsham	270 + 62	128	T-Beam	33.5	H-15	20	350	458	508	2,500*	3
	Vt. 25	Topsham	291 + 38	-	Box	6	H-15	20	350	459	508	500*	3
	Vt. 113	Fairlee	94 + 36	-	Box	7	H-15	20	250	328	362	700*	3
	U.S. 5	Bradford	283 + 17 FA	162	Slab	25	H-15	20	770	1009	1117	4,000*	3
	U.S. 5	Newbury	58 + 87 FA	68	T-Beam	48	H-15	20	750	983	1088	2,000*	3
	U.S. 5	Thetford	266 + 52 FA	163	Slab	24	H-15	20	630	825	915	4,000*	3
	U.S. 5	Thetford	78 + 37 FA	-	Concrete Slab	15	H-15	20	600	786	870	10,000*	3

* Included in Proposed Ten Year Program.

1/ Ordinarily these bridges would serve traffic for a number of years to come, but because of their inclusion in road projects it is considered more economical to improve them when the road is improved, because of changes in grade, alignment and roadway width.

2/ Stations refer to straight line diagrams. Federal-aid is indicated by FA.

3/ Number assigned by Highway Planning Survey.

4/ Classified in the order of importance by Bridge Department.
Class 2. Inadequate because of alignment or narrow roadway.
Class 3. Bridges having a roadway width less than 24 feet but otherwise adequate.

BRIDGES ON THE STATE SYSTEM WHICH REQUIRE IMPROVEMENT BECAUSE OF THEIR INCLUSION IN ROAD PROJECTS /1

County	Route	Town	Station /2	HPS No. /3	Type	Span	Loading Capacity	Horizontal Clearance	Average 24-Hour Traffic			Estimated Cost of Improvement	Class /4
										Estimated			
									1937	1945	1950		
						Feet		Feet	Vehicles	Vehicles	Vehicles		
Orleans	Vt. 12	Greensboro	215 + 35	92	Slab	23	H-15	20	325	426	471	$ 1,800*	3
	Vt. 12	Glover	137 + 75	-	Slab	9	H-15	20	325	426	471	1,500*	3
	Vt. 12	Glover	203 + 57	-	Box	6	H-15	20	350	459	508	900*	3
	Vt. 12	Glover	215 + 03	-	Slab	16	H-15	20	350	459	508	1,500*	3
	Vt. 5-A	Brownington	190 + 52	-	Box	6	H-15	20	300	393	435	600*	3
	U.S. 5	Barton	137 + 90 FA	22	Slab	24	H-15	20	650	852	943	2,500*	3
	Vt. 100	Lowell	45 + 20 FA	-	Concrete Box	6	H-15	20	250	328	363	600*	3
	Vt. 100	Lowell	54 + 07 FA	-	Stone Box	7	H-15	20	250	328	363	700*	3
	Vt. 100	Lowell	68 + 72 FA	-	Concrete Slab	12	H-15	20	250	328	363	1,000*	3
	U.S. 5	Barton	7 + 40 FA	-	Concrete Slab	8½	H-15	20	650	852	943	1,200*	3
	U.S. 5	Barton	85 + 83 FA	-	Concrete Slab	10	H-15	20	650	852	943	1,200*	3
	U.S. 5	Barton	97 + 05 FA	-	Concrete Slab	10	H-15	20	650	852	943	1,400*	3
Rutland	Vt. 30	Pawlet	10 + 64	-	Slab	11	H-15	20	380	498	551	1,000*	3
	Vt. 30	Pawlet	68 + 85	-	Box	7	H-15	20	380	498	551	600*	3
	Vt. 30	Hubbardton	218 + 69	-	Box	8	H-15	20	400	524	580	700*	3
	U.S. 7	Clarendon	206 + 85 FA	-	Concrete Box	12	H-15	20	3200	4192	4640	1,000*	3
	U.S. 7	Danby	52 + 91 FA	-	Concrete Box	8	H-15	20	1350	1769	1958	1,000*	3
	U.S. 4	Sherburne	357 + 01 FA	-	Concrete Box	16	H-15	22	700	917	1015	3,000*	3
	U.S. 4	Sherburne	408 + 93 FA	-	Concrete Slab	16	H-15	20	950	1245	1378	2,000*	3
	U.S. 4	Ira	18 + 07 FA	-	Concrete Slab	13	H-15	20	2350	3079	3408	3,000*	3
Washington	Vt. 12	Calais	227 + 62	-	Box	6	H-15	22	375	492	544	1,000*	3
	Vt. 12	Woodbury	71 + 36	-	Slab	11	H-15	20	325	427	471	1,500*	3
	Vt. 12	Woodbury	135 + 42	-	Slab	12½	H-15	20	250	328	363	1,500*	3
	Vt. 12	Woodbury	350 + 18	-	Box	6	H-15	22	250	328	363	900*	3
	U.S. 2	E.Montpelier	231 + 12 FA	-	Stone Box	8	H-15	20	1250	1638	1813	800*	3
	Vt. 30	Dummerston	244 + 27	-	Slab	15	H-15	22	600	786	870	1,000*	3
	U.S. 5	Putney	38 + 60 FA	178	T-Beam	53	H-15	20	1600	2096	2320	15,000*	2
Windsor	Vt. 100	Plymouth	126 + 36	202	T-Beam	48	H-15	20	210	275	305	4,000*	3
	Vt. 100	Plymouth	169 + 46	187	I-Beam	38	H-15	18	210	275	305	3,500*	3
	Vt. 100	Stockbridge	143 + 52	268	Truss	106	H-15	20	175	230	255	10,000*	3
	Vt. 106	Woodstock	131 + 90	341	Arch	28	H-15	21	300	393	435	8,000*	2
	Vt. 106	Reading	119 + 75	207	I-Beam	30	H-15	17½	200	262	290	4,000*	3
	Vt. 106	Reading	225 + 73	210	Concrete Slab	20	H-15	18	150	197	218	2,500*	2
	Vt. 100	Stockbridge	178 + 72	-	Slab	12	H-15	21	300	393	435	1,000*	3
	Vt. 12	Hartland	157 + 50	-	Box	6	H-15	20	240	314	348	1,500*	3
	Vt. 12	Hartland	216 + 14	-	Slab	6	H-15	20	240	314	348	1,000*	3
	Vt. 12	Woodstock	168 + 21	-	Box	9	H-15	20	300	393	435	1,200*	3
	Vt. 12	Barnard	314 + 13	-	Box	10	H-15	20	200	262	290	1,500*	3
	Vt. 12	Barnard	411 + 91	-	Box	10	H-15	22	200	262	290	1,500*	3
	Vt. 14	Royalton	417 + 83 FA	237	T-Beam	105	H-15	22	780	1022	1131	7,000*	3
	U.S. 5	Weathersfield	253 + 95 FA	292	T-Beam	75	H-15	20	1100	1441	1595	10,000*	3
	U.S. 4	Bridgewater	249 + 52 FA	51	Truss	79	H-15	20	725	950	1051	20,000*	3
	U.S. 4	Bridgewater	286 + 11 FA	52	Trues	78	H-15	20	725	950	1051	20,000*	3
	U.S. 4	Sherburne	277 + 93 FA	62	T-Beam	35	H-15	20	725	950	1051	3,000*	2
	U.S. 5	Norwich	48 + 71 FA	179	Slab	24	H-15	20	800	1048	1160	5,000*	3
	Vt. 14	Sharon	212 + 86 FA	-	Slab	10	H-15	20	1100	1441	1595	3,000*	3
	Vt. 14	Sharon	347 + 40 FA	-	Concrete Box	8	H-15	20	1100	1441	1595	1,200*	3
	U.S. 5	Springfield	175 + 07 FA	-	Concrete Box	12	H-15	20	750	983	1088	10,000*	3

* Included in Proposed Ten Year Program.

1/ Ordinarily these bridges would serve traffic for a number of years to come, but because of their inclusion in road projects it is considered more economical to improve them when the road is improved, because of changes in grade, alignment and roadway width.

2/ Stations refer to straight line diagrams. Federal-aid is indicated by FA.

3/ Number assigned by Highway Planning Survey.

4/ Classified in the order of importance by Bridge Department.
Class 2. Inadequate because of alignment or narrow roadway.
Class 3. Bridges having a roadway width less than 24 feet but otherwise adequate.

Route U.S. 4
County - Rutland

TABLE G.

ESTIMATED COST OF CONSTRUCTING THE STATE SYSTEM TO CERTAIN STANDARDS

Station	Town	From Local Designation	Station	To Local Designation	Section Length	Present Status		Traffic			Deficiency Index			Type of Proposed Improvement /4	Estimated Cost
						Type /1	Width	1937	Estimated 1945	Estimated 1950	Loc. /3	Width	Type		
0.00	Sherburne	Sherburne TL	0.80	0.80 West	0.80	MIP	18'	700	917	1015	2.30	- -	- -	Reconst.	$ 32,000
0.25		Bridge	-	----	66'	Truss	20'	700	917	1015	0.40	- -	- -	- - - - - -	- - - -
0.80		Previous Section	1.65	0.80 West	0.85	MIP	18'	700	917	1015	2.89	- -	- -	Reconst.	68,000
1.65		Bridge	-	----	33'	T-Beam	20'	700	917	1015	0.25	- -	- -	- - - - - -	- - - -
1.65		Previous Section	1.75	0.10 West	0.10	MIP	18'	700	917	1015	1.80	- -	- -	Reconst.	7,500
1.75		Previous Section	4.15	2.40 West	2.40	MIP	18'	700	917	1015	0.60	- -	- -	- - - - - -	- - - -
4.15		Previous Section	4.35	0.20 West	0.20	MIP	18'	700	917	1015	1.31	- -	- -	Reconst.	5,000
4.35		Bridge	-	----	34'	T-Beam	20'	700	917	1015	0.40	- -	- -	- - - - - -	- - - -
4.35		Previous Section	5.35	1.00 West	1.00	MIP	18'	700	917	1015	2.81	- -	- -	Reconst.	36,000
5.35		Previous Section	6.35	Jct. Vt. 100	1.00	MIP	18'	700	917	1015	2.23	- -	- -	Reconst.	50,000
6.35		Jct. Vt. 100	7.95	1.60 West	1.60	MIP	18'	950	1245	1378	3.36	- -	- -	Reconst.	120,000
6.75		Box	-	----	16'	Box	22'	950	1245	1378	C1.3	- -	- -	- - - - - -	- - - -
7.50		Bridge	-	----	23'	Slab	20'	950	1245	1378	0.60	- -	- -	- - - - - -	- - - -
7.70		Bridge	-	----	16'	Conc.	20'	950	1245	1378	C1.3	- -	- -	- - - - - -	- - - -
7.95		Previous Section	9.15	Side Rd. Lt.	1.20	MIP	18'	950	1245	1378	3.04	- -	- -	Reconst.	90,000
8.75	Mendon	TL	-	----	-	---	-	-	-	-	- -	- -	- -	- - - - - -	- - - -
9.15		Side Rd. Lt.	12.20	Begin FR 5-A	3.05	MIP	18'	1000	1310	1450	2.04	1.0	- -	Reconst.	152,500
12.10		Bridge	-	----	11'	Arch	20'	1000	1310	1450	C1.1	- -	- -	Rebuild	6,000
12.20		Begin FR 5-A	13.40	End B.M.	1.20	MIP	18'	1000	1310	1450	3.46	1.0	- -	Reconst.	50,400
12.25		Bridge	-	----	64'	I-Beam	20'	1000	1310	1450	0.60	- -	- -	- - - - - -	- - - -
13.40		End B.M.	13.85	0.45 West	0.45	STG	18'	1100	1441	1595	0.69	1.1	1.1	Reconst.	18,900
13.85		Previous Section	15.95	Rut.City Line	2.10	---	-	1200	1572	1740	- -	- -	- -	Under Const.	- - - -
14.70	Rutland	TL	-	----	-	---	-	-	-	-	- -	- -	- -	- - - - - -	- - - -
15.45		Box	-	----	12'	Slab	24'	1200	1572	1740	- -	- -	- -	Under Const.	- - - -
15.95	Rutland City	Rut.City Line(SA)	17.20	Jct. U.S.7(North)	1.25	Conc.	30'	-	-	-	- -	- -	- -	- - - - - -	- - - -
		Jct.U.S.7 (North) to Jct.		U.S.7 (South) not	included.										
17.20		Jct.U.S.7 (South)(SA)	17.45	End STG	0.25	STG	30'	-	-	-	- -	- -	- -	- - - - - -	- - - -
17.45		End STG (SA)	18.20	W.end NRM 65-E	0.75	Conc.	30'	-	-	-	- -	- -	- -	- - - - - -	- - - -
18.10		Bridge (SA)	-	----	75½'	I-Beam	31'	6000	7860	8700	0.00	- -	- -	- - - - - -	- - - -
18.20		Previous Section(SA)	19.10	Rutland TL	0.90	Conc.	18'	-	-	-	- -	- -	- -	Multi.Lane	72,000

1/ STG - Surface treated gravel
MIP - Gravel mixed-in-place
Conc. - Concrete
Mac. - Macadam
L.Fl. - Lights Flashing

3/ Loc. - Location or alignment index.

4/ Reconst. - Reconstruct
Multi.Lane - Multiple Lane Construction

Route U.S. 4
County - Rutland

TABLE G.

ESTIMATED COST OF CONSTRUCTING THE STATE SYSTEM TO CERTAIN STANDARDS

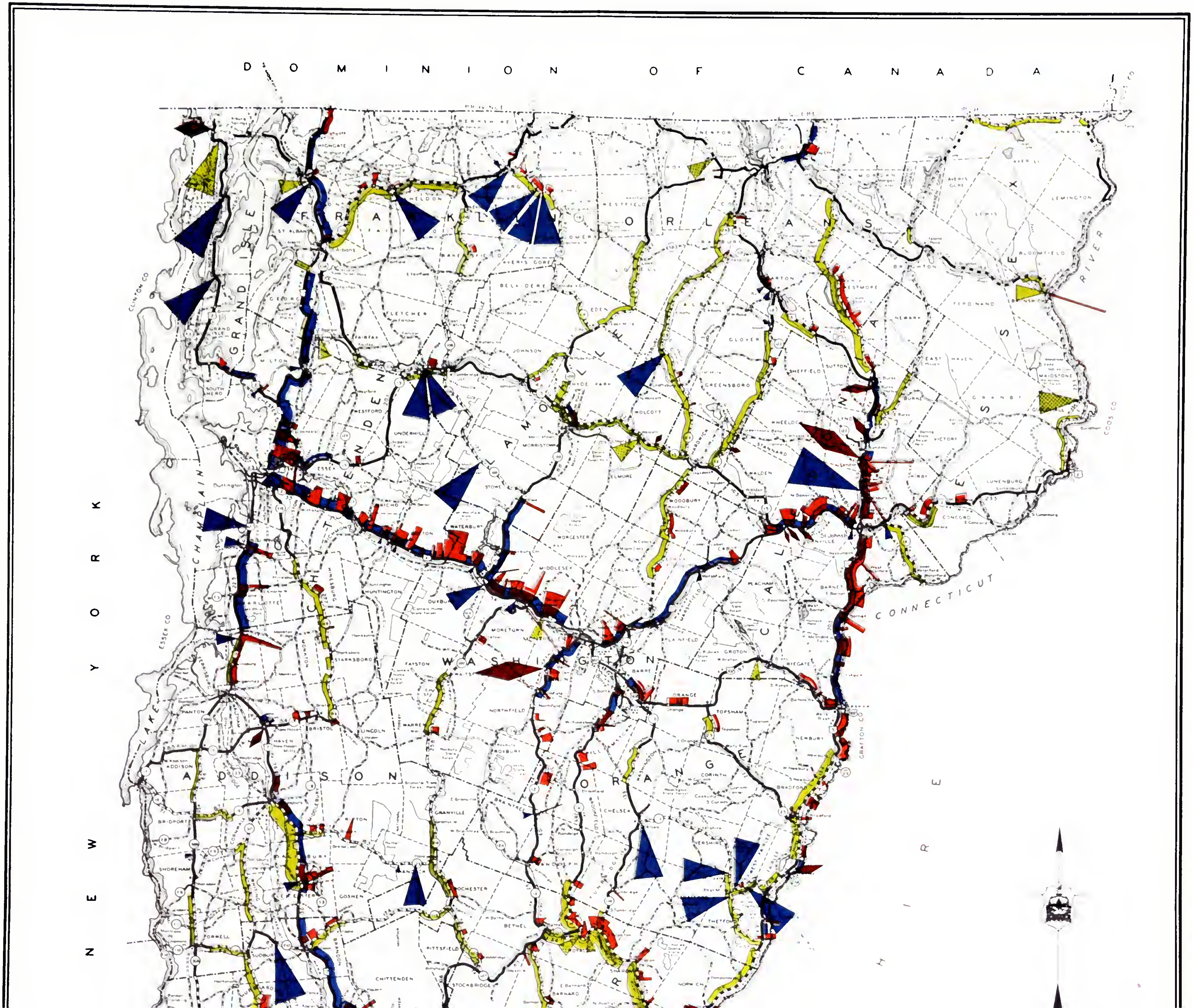
Station	Town	From Local Designation	Station	To Local Designation	Section Length	Present Status Type /1	Present Status Width	Traffic /2 1937	Traffic Estimated 1945	Traffic Estimated 1950	Deficiency Index Loc. /3	Deficiency Index Width	Deficiency Index Type	Type of Proposed Improvement /4	Estimated Cost
19.10	Rutland	Rutland TL	19.30	Jct. Vt. 3	0.20	Conc.	18'	4000M	5240	5800	5.80	4.00	- -	Multi.Lane	$ 16,000
19.30		Jct. Vt. 3	20.05	W. Rutland TL	0.75	Conc.	18'	3100	4061M	4495	3.37	3.1	- -	Multi.Lane	60,000
19.35		Underpass	-	----	-	Girder	36'	3100	4061M	4495	3.70	- -	- -	- - - - - -	- - - -
19.45		Bridge	-	----	116'	Truss	20'	3100	4061M	4495	5.00	- -	- -	Widening	4,000
19.55		Underpass	-	----	-	Girder	36'	3100	4061M	4495	1.90	- -	- -	- - - - - -	- - - -
19.70		Grade Xing	-	----	-	Signs	-	3100	4061M	4495	4.0	- -	- -	Eliminete	85,000
19.80		Bridge	-	----	52'	I-Beam	20'	3100	4061M	4495	1.60	- -	- -	Widening	7,000
20.05	W.Rutland	W.Rutland TL	20.30	0.25 West	0.25	Conc.	18'	3100	4061M	4495	11.9	3.1	- -	Multi.Lane	22,000
20.30		Previous Section	20.95	End St. Hwy.	0.65	Conc.	18'	3100	4061M	4495	5.99	3.1	- -	Multi.Lane	50,000
20.90		Grade Xing	-	----	-	L.Fl.	-	3100	4061M	4495	3.2	- -	- -	Eliminate	80,000
20.95	West	End St. Hwy. (SA)	21.30	Side Rd. Lt.	0.35	Conc.	18'	-	-	-	0.00	- -	- -	Multi.Lane	17,000
20.95	Rutland	Bridge (SA)	-	----	16'	Slab	30'	3100	4061M	4495	Cl.4	- -	- -	- - - - - -	- - - -
21.30	Village	Side Rd. Lt. (SA)	21.40	Marble St.	0.10	Conc.	18'	-	-	-	- -	- -	- -	Multi.Lane	3,500
21.40		Previous Section(SA)	21.95	Begin St. Hwy.	0.55	Conc.	18'	-	-	-	0.00	- -	- -	Multi.Lane	17,000
21.95		Begin St. Hwy.	22.55	Side Rd. Rt.	0.60	Conc.	18'	2400	3144	3480	0.00	2.4	- -	Widening	46,000
22.55		Side Rd. Rt.	23.55	1.00 West	1.00	Conc.	18'	2350	3079	3408	1.34	2.35	- -	Reconst.	55,000
23.55		Previous Section	24.45	0.90 West	0.90	Conc.	18'	2350	3079	3408	5.10	2.35	- -	Reconst.	45,000
23.75	Ira	Ira TL	-	----	-	---	-	-	-	-	- -	- -	- -	- - - - - -	- - - -
24.10		Bridge	-	----	13'	Slab	20'	2350	3079	3408	Cl.3	- -	- -	- - - - - -	- - - -
24.45		Previous Section	28.15	End St. Hwy.	3.70	Conc.	18'	2350	3079	3408	1.56	2.35	- -	Widening	56,000
25.00		Box	-	----	10'	Box	20'	2350	3079	3408	Cl.3	- -	- -	- - - - - -	- - - -
25.05	Castleton	TL	-	----	-	---	-	-	-	-	- -	- -	- -	- - - - - -	- - - -
25.10		Bridge	-	----	46'	T-Beam	20'	2350	3079	3408	1.30	- -	- -	- - - - - -	- - - -
26.25		Bridge	-	----	46'	T-Beam	20'	2350	3079	3408	1.40	- -	- -	- - - - - -	- - - -
26.85		Box	-	----	6'	Box	20'	2350	3079	3408	Cl.3	- -	- -	- - - - - -	- - - -

1/ Conc. - Concrete
L.Fl. - Lights Flashing

2/ M - Multiple lanes required.

3/ Loc. - Location or alignment index.

4/ Reconst. - Reconstruct
Multi.Lane - Multiple Lane Construction


DOMINION OF CANADA
NEW YORK
CLINTON CO.
ESSEX CO.
LAKE CHAMPLAIN
GRAND ISLE
FRANKLIN
ORLEANS
ESSEX
CHITTENDEN
LAMOILLE
CALEDONIA
WASHINGTON
ADDISON
ORANGE
CONNECTICUT RIVER
NEW HAMPSHIRE
COOS CO.
GRAFTON CO.
HIGHGATE
SHELDON
FLETCHER
JOHNSON
BELVIDERE
EDEN
GLOVER
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WOLCOTT
HYDE PARK
MORRISTOWN
STOWE
UNDERHILL
WESTFORD
ESSEX
JERICHO
WATERBURY
WORCESTER
MIDDLESEX
ELMORE
WOODBURY
CALAIS
MORETOWN
DUXBURY
HUNTINGTON
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PITTSFIELD
STOCKBRIDGE
CHITTENDEN
BARNARD
GOSHEN
LINCOLN
BRISTOL
PANTON
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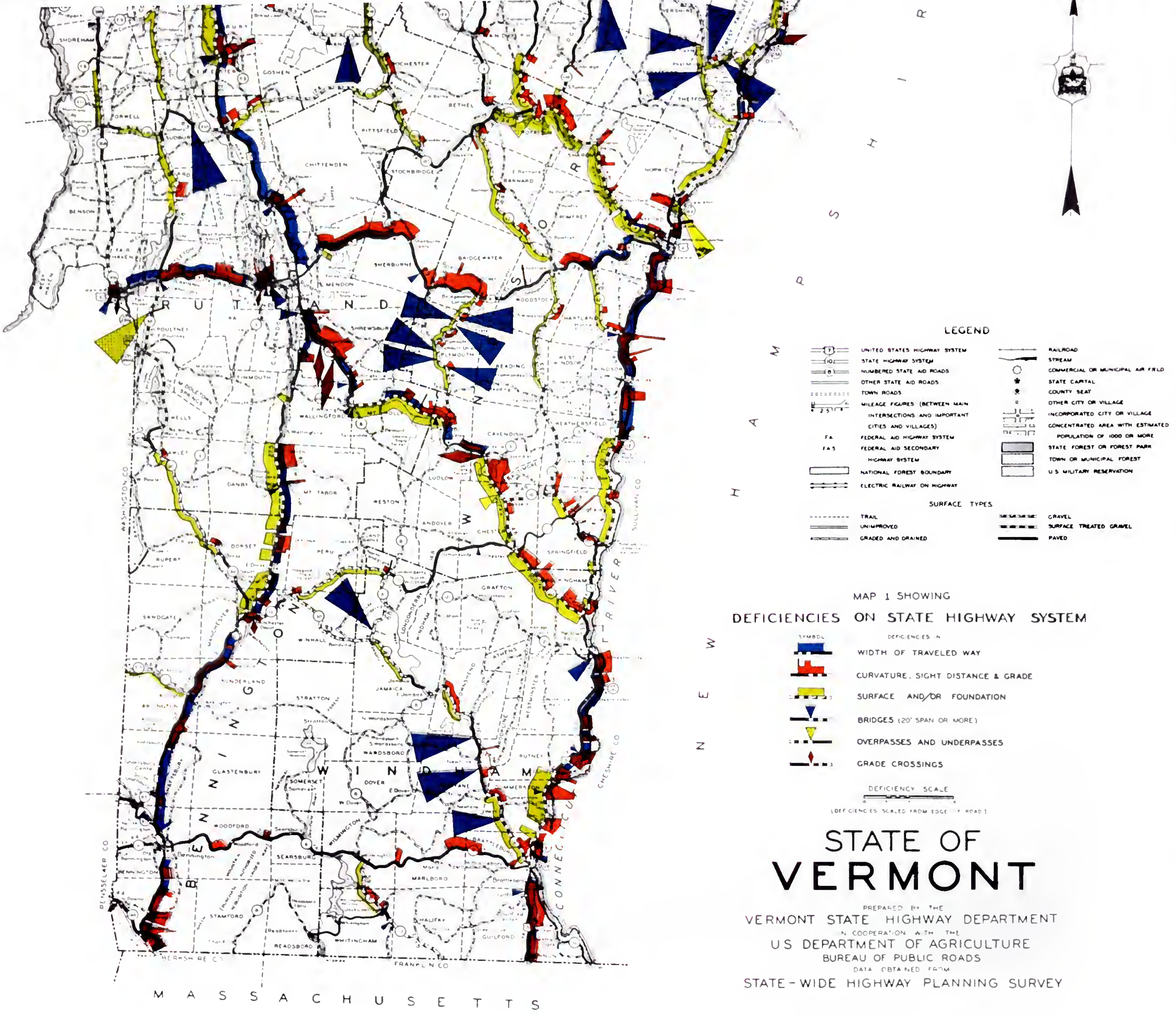
SOUTH HERO
BURLINGTON



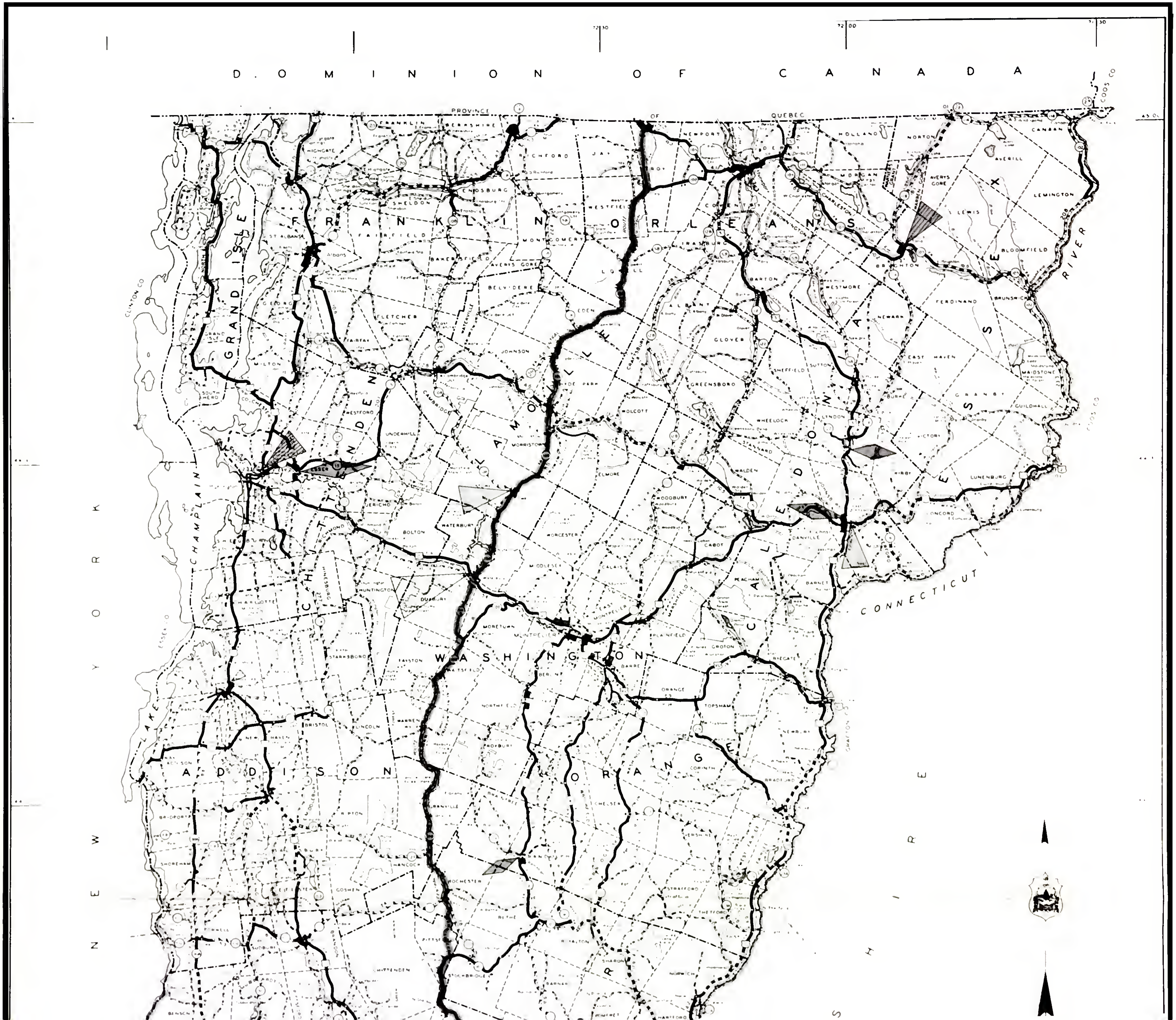
MAP 1 SHOWING

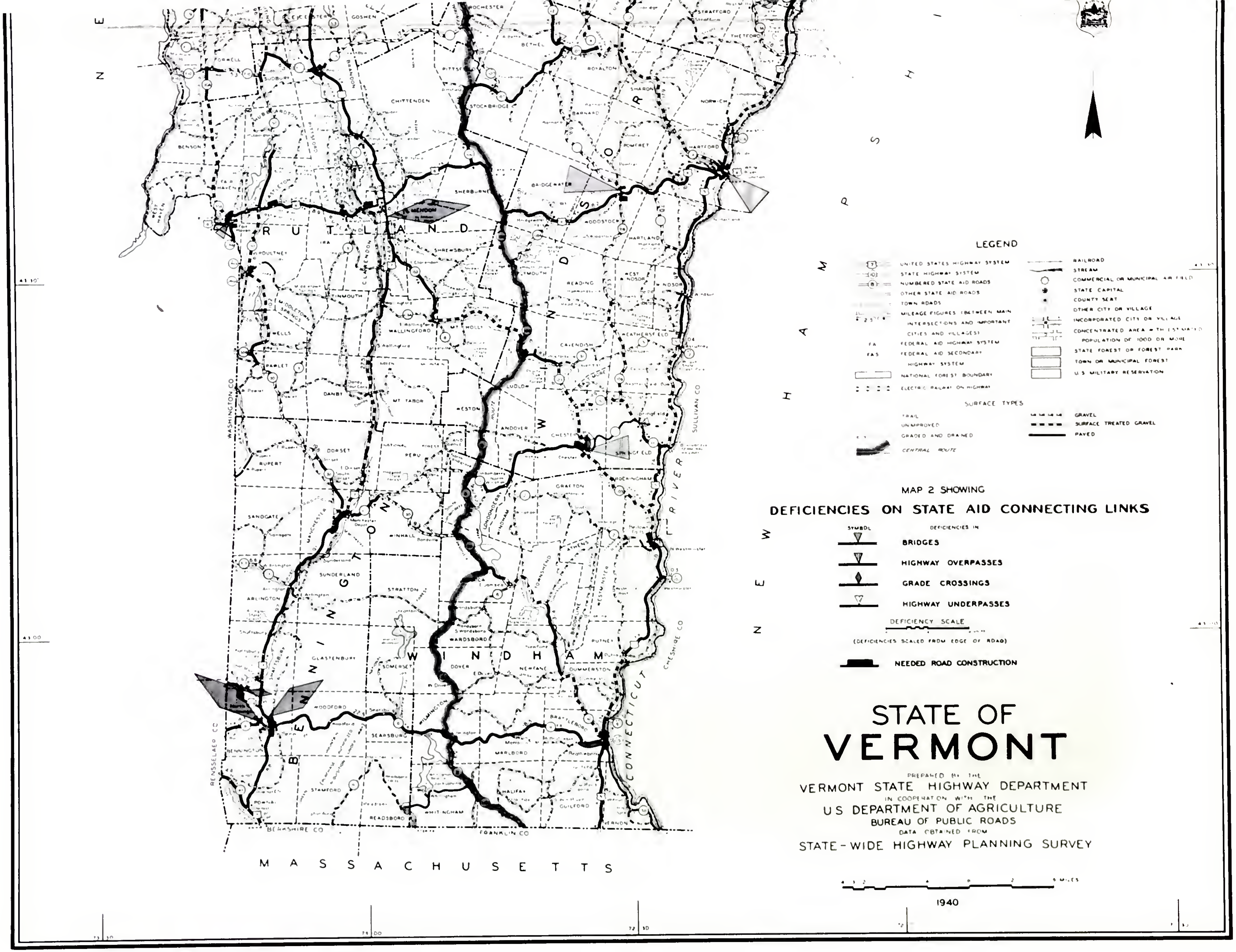
DEFICIENCIES ON STATE HIGHWAY SYSTEM

STATE OF
VERMONT

PREPARED BY THE
VERMONT STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
U S DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS
DATA OBTAINED FROM
STATE-WIDE HIGHWAY PLANNING SURVEY

1940


72 30
72 00
71 30
DOMINION OF CANADA
PROVINCE OF QUEBEC
COOS CO
CLINTON CO
ESSEX CO
NEW YORK
LAKE CHAMPLAIN
CONNECTICUT RIVER
NEW HAMPSHIRE
GRAND ISLE
FRANKLIN
ORLEANS
ESSEX
CHITTENDEN
LAMOILLE
CALEDONIA
WASHINGTON
ADDISON
ORANGE
HIGHGATE
SHELDON
ENOSBURG
RICHFORD
BERKSHIRE
JAY
TROY
NEWPORT
HOLLAND
NORTON
CANAAN
AVERILL
AVERYS GORE
LEMINGTON
LEWIS
BLOOMFIELD
BRIGHTON
MORGAN
CHARLESTON
ST ALBANS
FAIRFIELD
BAKERSFIELD
MONTGOMERY
WESTFIELD
LOWELL
BELVIDERE
FLETCHER
EDEN
JOHNSON
FAIRFAX
MILTON
SOUTH HERO
COLCHESTER
BARTON
WESTMORE
GLOVER
NEWARK
FERDINAND
BRUNSWICK
EAST HAVEN
MAIDSTONE
GRANBY
GUILDHALL
SUTTON
SHEFFIELD
GREENSBORO
HYDE PARK
WOLCOTT
WESTFORD
UNDERHILL
CAMBRIDGE
MORRISTOWN
WHEELOCK
LYNDON
VICTORY
KIRBY
LUNENBURG
CONCORD
STANNARD
WALDEN
ELMORE
WOODBURY
CABOT
DANVILLE
JERICHO
BOLTON
WATERBURY
WORCESTER
MIDDLESEX
CALAIS
PEACHAM
BARNET
HUNTINGTON
DUXBURY
MORETOWN
MONTPELIER
EAST MONTPELIER
PLAINFIELD
GROTON
RYEGATE
STARKSBORO
FAYSTON
BERLIN
BARRE
ORANGE
TOPSHAM
NEWBURY
CORINTH
BRADFORD
BRISTOL
LINCOLN
WARREN
ROXBURY
CHELSEA
VERSHIRE
STRAFFORD
THETFORD
GRANVILLE
BRAINTREE
HANCOCK
ROCHESTER
GOSHEN
BETHEL
ROYALTON
SHARON
CHITTENDEN
PITTSFIELD
STOCKBRIDGE
BARNARD
POMFRET
HARTFORD
NORWICH
SHOREHAM
BRIDPORT
RIPTON



MAP 2 SHOWING

DEFICIENCIES ON STATE AID CONNECTING LINKS

STATE OF
VERMONT

PREPARED BY THE
VERMONT STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
U S DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS
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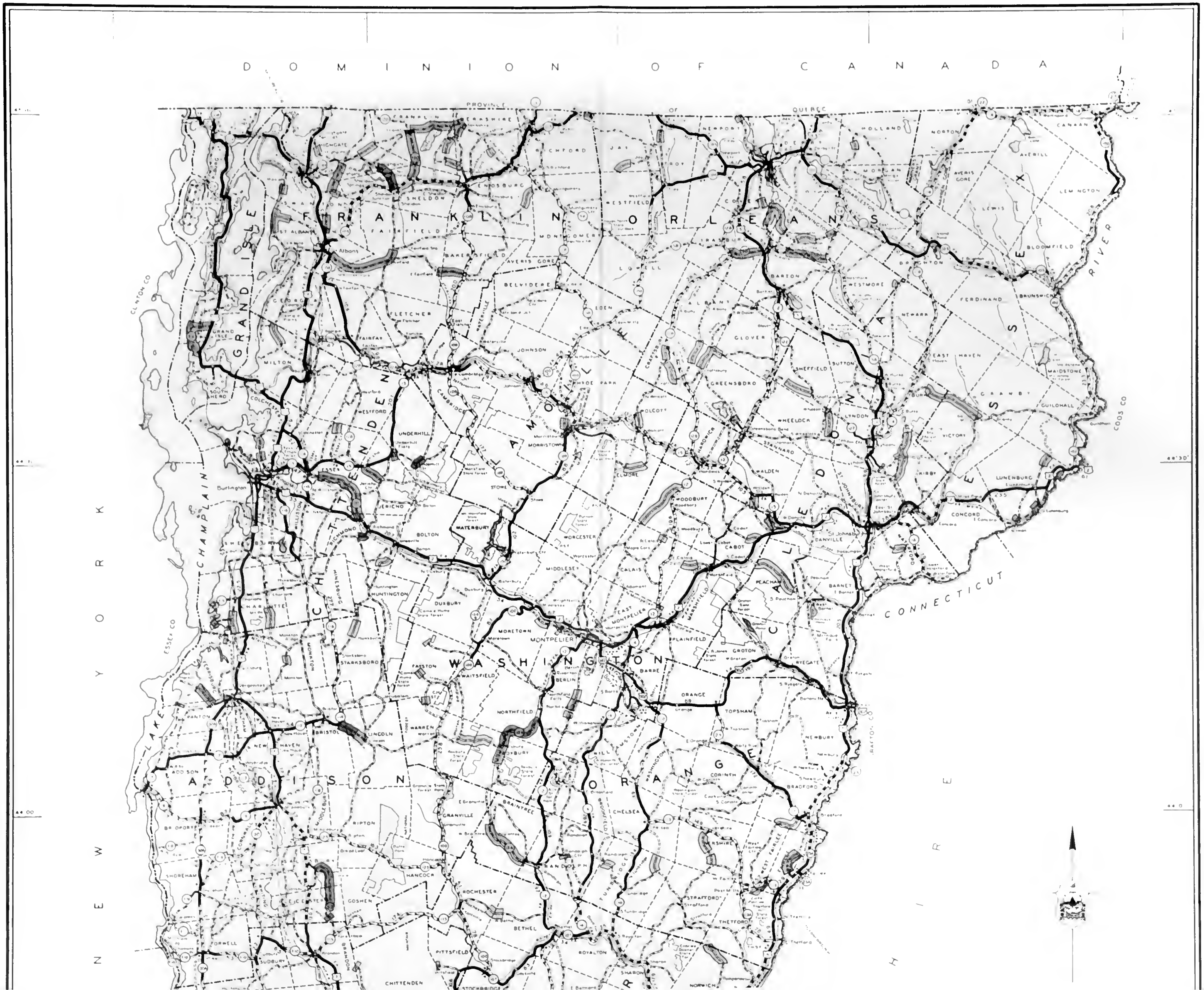
STATE-WIDE HIGHWAY PLANNING SURVEY

1940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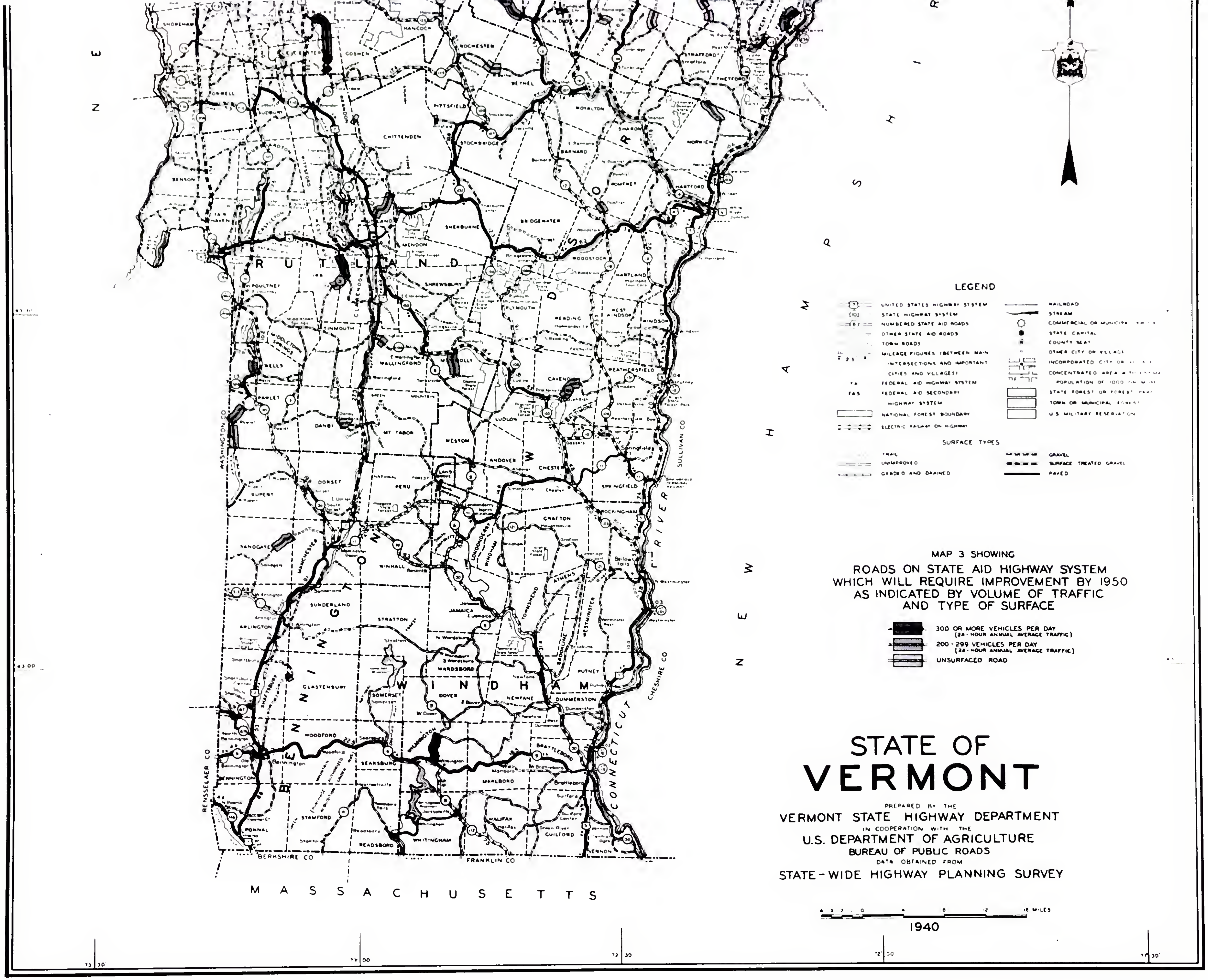
PROVINCE of QUEBEC
NEW YORK
LAKE CHAMPLAIN
CLINTON CO
ESSEX CO
GRAND ISLE
FRANKLIN
ORLEANS
ESSEX
LAMOILLE
CHITTENDEN
CALEDONIA
WASHINGTON
ADDISON
ORANGE
CONNECTICUT
RIVER
COOS CO
GRAFTON CO
NEW HAMPSHIRE
HIGHGATE
SHELDON
FAIRFIELD
ENOSBURG
RICHFORD
JAY
TROY
NEWPORT
HOLLAND
NORTON
CANAAN
AVERILL
LEMINGTON
LEWIS
BLOOMFIELD
BRUNSWICK
FERDINAND
MAIDSTONE
GRANBY
GUILDHALL
LUNENBURG
CONCORD
VICTORY
EAST HAVEN
NEWARK
BRIGHTON
WESTMORE
BARTON
GLOVER
SHEFFIELD
SUTTON
LYNDON
WHEELOCK
GREENSBORO
WALDEN
DANVILLE
BARNET
PEACHAM
CABOT
MARSHFIELD
GROTON
RYEGATE
BELVIDERE
EDEN
JOHNSON
HYDE PARK
WOLCOTT
MORRISTOWN
ELMORE
STOWE
WOODBURY
WORCESTER
CALAIS
MIDDLESEX
EAST MONTPELIER
MONTPELIER
PLAINFIELD
BARRE
BERLIN
ORANGE
TOPSHAM
NEWBURY
BRADFORD
CORINTH
CHELSEA
TUNBRIDGE
STRAFFORD
THETFORD
NORWICH
SHARON
ROYALTON
BETHEL
ROCHESTER
PITTSFIELD
CHITTENDEN
STOCKBRIDGE
GRANVILLE
BRAINTREE
NORTHFIELD
MORETOWN
WATERBURY
DUXBURY
FAYSTON
WAITSFIELD
WARREN
LINCOLN
BRISTOL
NEW HAVEN
PANTON
ADDISON
BRIDPORT
SHOREHAM
CORNWALL
MIDDLEBURY
RIPTON
HANCOCK
GOSHEN
ORWELL
SUDBURY
BRANDON
STARKSBORO
HUNTINGTON
HINESBURG
RICHMOND
BOLTON
JERICHO
UNDERHILL
WESTFORD
CAMBRIDGE
FLETCHER
FAIRFAX
MILTON
COLCHESTER
ESSEX
WILLISTON
Burlington
St. Albans
GEORGIA
SOUTH HERO
GRAND ISLE
WEST FAIRLEE
St. Johnsbury
BAKERSFIELD
MONTGOMERY
WESTFIELD
LOWELL
IRASBURG
CRAFTSBURY
STANNARD
KIRBY
WATERFORD
CHARLESTON
MORGAN
AVERYS GORE
WARREN GORE



MAP 3 SHOWING
ROADS ON STATE AID HIGHWAY SYSTEM WHICH WILL REQUIRE IMPROVEMENT BY 1950 AS INDICATED BY VOLUME OF TRAFFIC AND TYPE OF SURFACE

STATE OF
VERMONT

PREPARED BY THE
VERMONT STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
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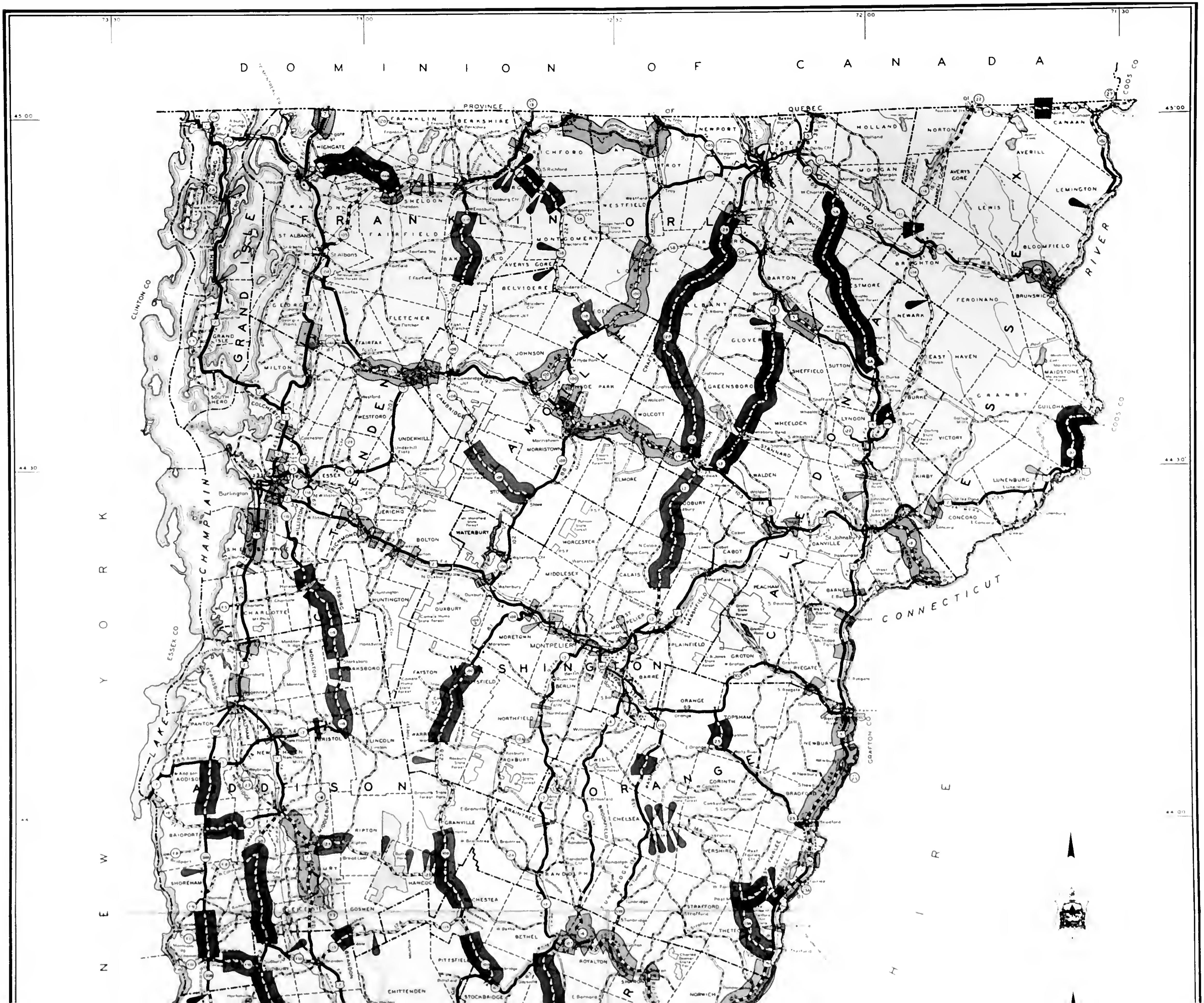
BUREAU OF PUBLIC ROADS
DATA OBTAINED FROM
STATE-WIDE HIGHWAY PLANNING SURVEY

1940


73°30
73°00
72°30
72°00
71°30
45°00
44°30
44°00
DOMINION OF CANADA
PROVINCE OF QUEBEC
COOS CO
NEW YORK
CLINTON CO
ESSEX CO
LAKE CHAMPLAIN
GRAND ISLE
FRANKLIN
ORLEANS
ESSEX
LAMOILLE
CHITTENDEN
CALEDONIA
WASHINGTON
ADDISON
ORANGE
CONNECTICUT RIVER
NEW HAMPSHIRE
GRAFTON CO
HIGHGATE
FRANKLIN
BERKSHIRE
RICHFORD
JAY
TROY
NEWPORT
DERBY
HOLLAND
NORTON
CANAAN
AVERILL
SHELDON
ENOSBURG
WESTFIELD
MORGAN
CHARLESTON
LEWIS
LEMINGTON
ST ALBANS
FAIRFIELD
MONTGOMERY
AVERYS GORE
BROWNINGTON
BRIGHTON
BLOOMFIELD
BELVIDERE
LOWELL
BARTON
WESTMORE
FERDINAND
BRUNSWICK
FLETCHER
WATERVILLE
ALBANY
GLOVER
NEWARK
FAIRFAX
JOHNSON
EDEN
EAST HAVEN
MAIDSTONE
MILTON
SHEFFIELD
SUTTON
GRANBY
SOUTH HERO
HYDE PARK
CRAFTSBURY
GREENSBORO
BURKE
GUILDHALL
COLCHESTER
WESTFORD
CAMBRIDGE
WOLCOTT
WHEELOCK
LYNDON
VICTORY
UNDERHILL
MORRISTOWN
STANNARD
KIRBY
ESSEX
ELMORE
WALDEN
LUNENBURG
Burlington
JERICHO
STOWE
HARDWICK
DANVILLE
CONCORD
WATERBURY
BOLTON
WORCESTER
CABOT
ST JOHNSBURY
WATERFORD
RICHMOND
MIDDLESEX
CALAIS
BARNET
SHELBURNE
HINESBURG
HUNTINGTON
PEACHAM
CHARLOTTE
DUXBURY
MARSHFIELD
MORETOWN
MONTPELIER
PLAINFIELD
GROTON
RYEGATE
MONKTON
STARKSBORO
FAYSTON
WAITSFIELD
BERLIN
BARRE
ORANGE
NEWBURY
FERRISBURG
PANTON
VERGENNES
BRISTOL
NORTHFIELD
TOPSHAM
NEW HAVEN
LINCOLN
WARREN
ROXBURY
WILLIAMSTOWN
ADDISON
CORINTH
BRADFORD
WEYBRIDGE
BRAINTREE
CHELSEA
BRIDPORT
RIPTON
GRANVILLE
BROOKFIELD
VERSHIRE
WEST FAIRLEE
SHOREHAM
HANCOCK
RANDOLPH
CORNWALL
MIDDLEBURY
SALISBURY
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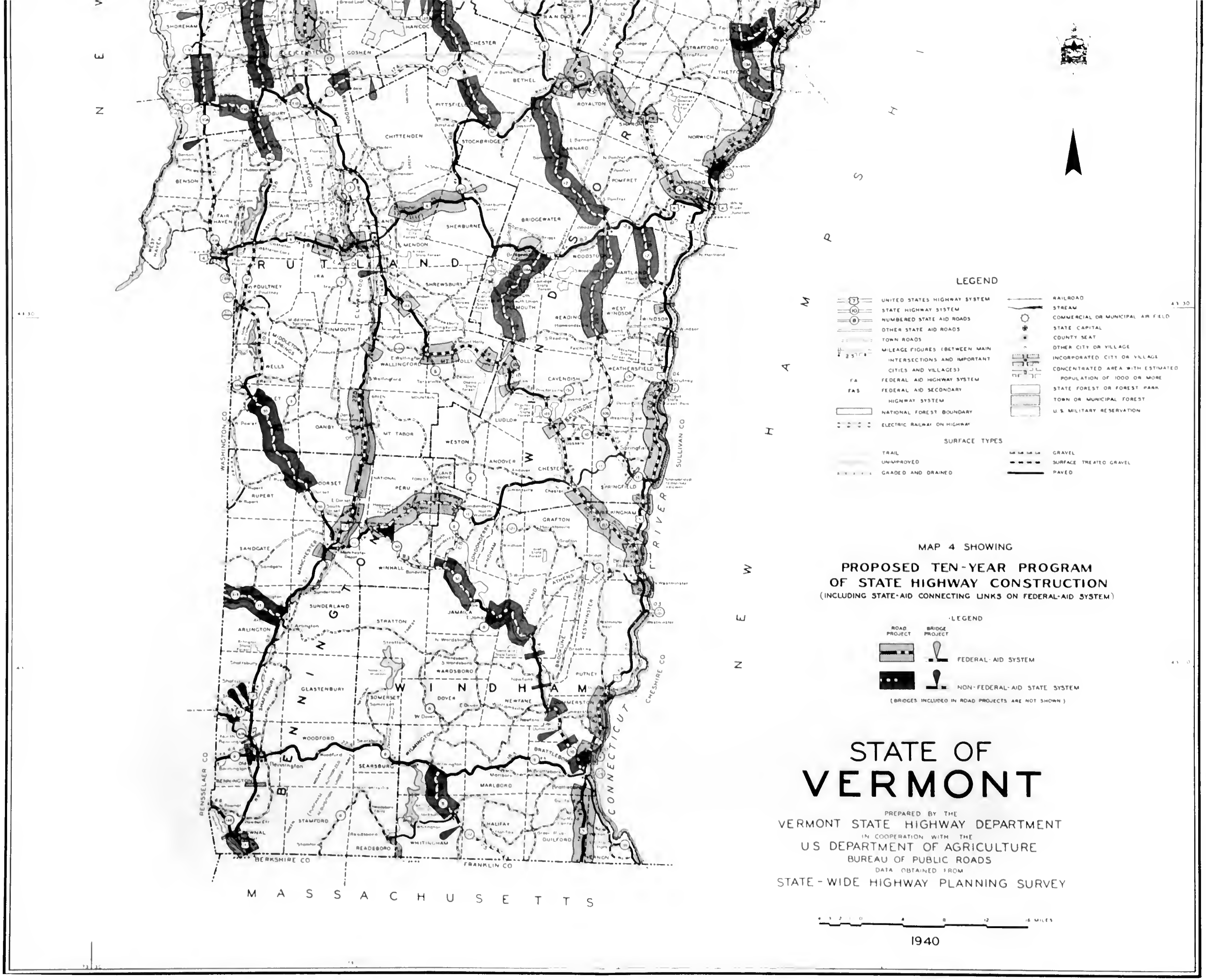
BETHEL
PITTSFIELD
ROYALTON
SHARON
CHITTENDEN
STOCKBRIDGE
NORWICH



MAP 4 SHOWING

PROPOSED TEN-YEAR PROGRAM OF STATE HIGHWAY CONSTRUCTION

(INCLUDING STATE-AID CONNECTING LINKS ON FEDERAL-AID SYSTEM)

STATE OF VERMONT

PREPARED BY THE
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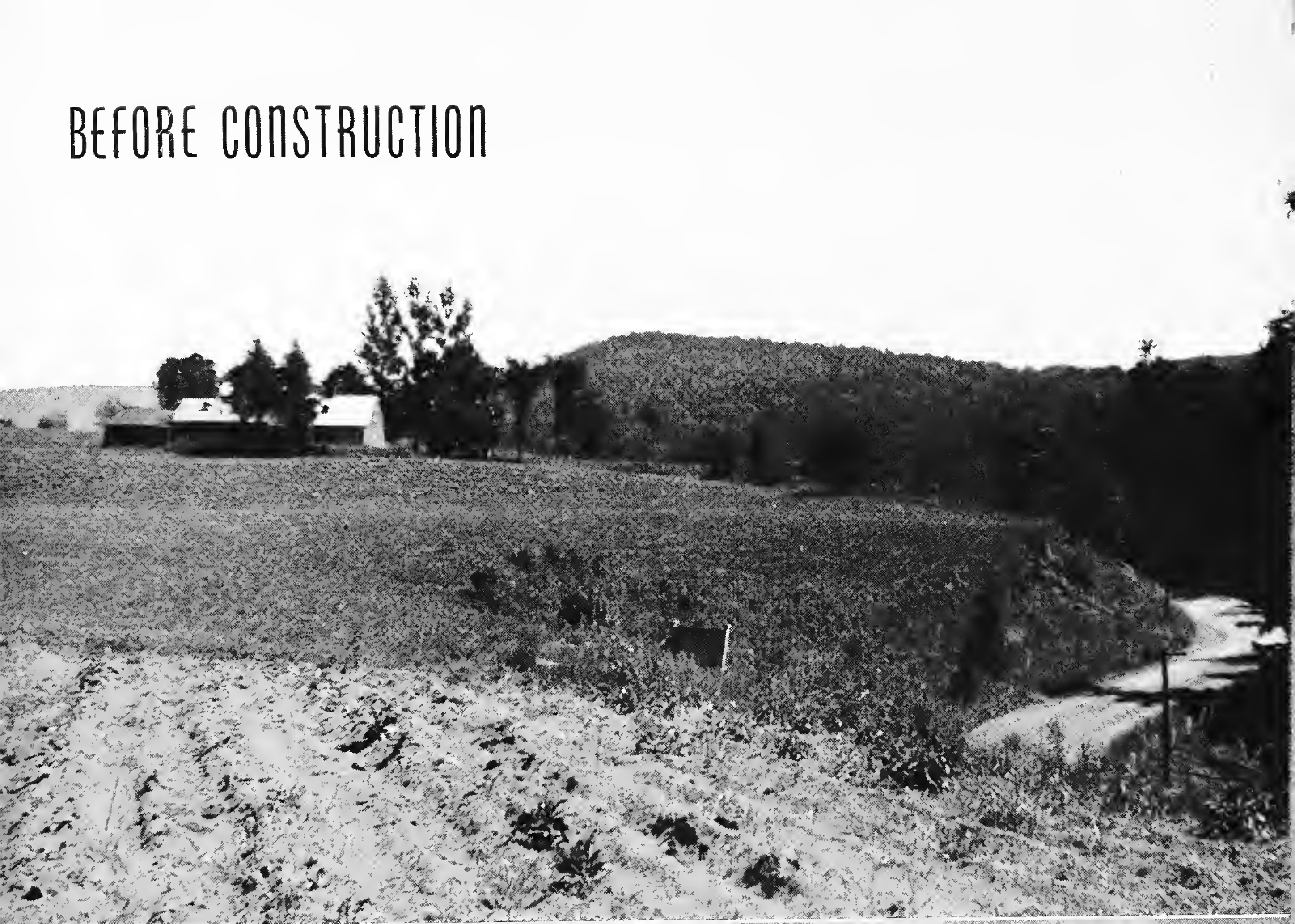
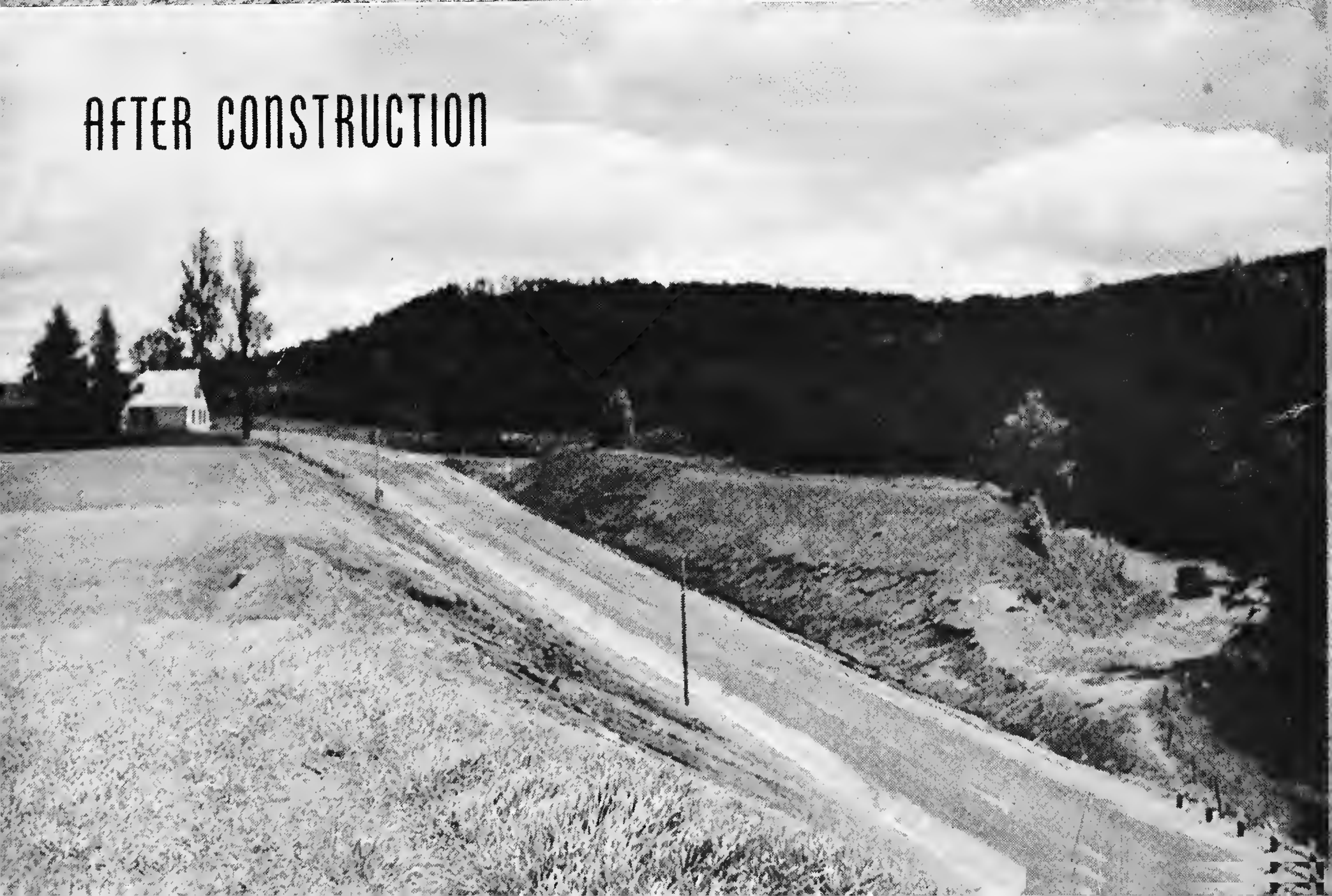


BEFORE CONSTRUCTION



AFTER CONSTRUCTION